PROVIDING THE TOOLS FOR SCIENTIFIC DISCOVERY AND BASIC ENERGY RESEARCH: THE DEPARTMENT OF ENERGY SCIENCE MISSION

HEARING

BEFORE THE

SUBCOMMITTEE ON ENERGY

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

ONE HUNDRED THIRTEENTH CONGRESS

FIRST SESSION

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October 30, 2013

PROVIDING THE TOOLS FOR SCIENTIFIC DISCOVERY AND BASIC ENERGY RESEARCH: THE DEPARTMENT OF ENERGY SCIENCE MISSION

WEDNESDAY, OCTOBER 30, 2013

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON ENERGY
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, D.C.

The Subcommittee met, pursuant to call, at 9:34 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Cynthia Lummis [Chairwoman of the Subcommittee] presiding.

LAMAR S. SMITH, Texas
CHAIRMAN

EDDIE BERNICE JOHNSON, Texas
RANKING MEMBER

Congress of the United States
House of Representatives

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Subcommittee on Energy

Providing the Tools for Scientific Discovery and Basic Energy Research: The Department of Energy Science Mission

Wednesday. October 30, 2013
9:30 a.m. – 11:30 a.m.
2318 Rayburn House Office Building

Witnesses

Dr. Patricia Dehmer, Deputy Director for Science Programs, Office of Science, Department of Energy

Dr. Horst Simon, Deputy Director, Lawrence Berkeley National Lab

Dr. John Hemminger, Chairman, Basic Energy Sciences Advisory Committee, Department of Energy

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON ENERGY

HEARING CHARTER

Providing the Tools for Scientific Discovery and Basic Energy Research: The Department of Energy Science Mission

Wednesday, October 30, 2013
9:30 – 11:30 a.m.
2318 Rayburn House Office Building

PURPOSE

The Subcommittee on Energy will hold a hearing entitled *Providing the Tools for Scientific Discovery and Basic Energy Research: The Department of Energy Science Mission* on Wednesday, October 30, at 9:30 a.m. in Room 2318 of the Rayburn House Office Building. The hearing will examine challenges and opportunities in setting priorities for the DOE's basic research mission as well as well as the execution of these fundamental science programs and activities within the Office of Science (SC). Additionally, the hearing will examine draft legislation *Enabling Innovation for Science, Technology, and Energy in America Act* (or EINSTEIN America Act)[1] of 2013 to provide authorization and direction to the DOE Office of Science.

WITNESS LIST

- **Dr. Patricia Dehmer,** Deputy Director for Science Programs, Office of Science, Department of Energy
- **Dr. Horst Simon,** Deputy Director, Lawrence Berkeley National Lab
- **Dr. John Hemminger,** Chairman, Basic Energy Sciences Advisory Committee, Department of Energy

BACKGROUND

The Department of Energy is the "lead federal agency supporting fundamental scientific research for energy and the Nation's largest supporter of basic research in the physical sciences."[2] The mission of the DOE's Office of Science (SC) is the delivery of scientific discoveries and major scientific tools that transform our understanding of nature and advance the energy, economic, and national security of the United States.[3]

The Office of Science budget and activities are divided into six major program areas:

- **Basic Energy Sciences (BES)** supports fundamental research to understand, predict, and ultimately control matter and energy at the electronic, atomic, and molecular levels and

[1] A Section by Section Analysis of the legislation is included as Appendix A.
[2] http://science.energy.gov/about/
[3] DOE Fiscal Year 2014 Budget Request, Volume 4, p. SC-3.

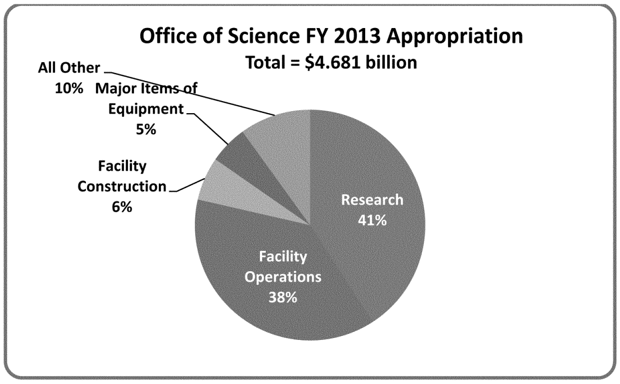
maintains world-class research facilities to develop facilitate advances in material science and chemistry.

- **Biological and Environmental Research (BER)** supports fundamental research focused on biological systems, climate, and environmental sciences, including work in genomics, climate change, and advanced environmental issues. The program also supports three DOE Bioenergy Research Centers, the Joint Genome Institute, and Environmental Molecular Sciences Laboratory.
- **Advanced Scientific Computing Research (ASCR)** supports research to discover, develop, and deploy computational and networking capabilities. The program is developing a program to position the Department to address scientific challenges that require 1,000 fold increases in computing capability and scientific data.
- **Fusion Energy Sciences (FES)** supports research to improve fundamental understanding of matter at very high temperatures and densities needed to develop fusion energy.
- **High Energy Physics (HEP)** probes the basic relationship between space and time, the elementary constituents of matter and energy, and the interactions between them. This effort focuses on three scientific frontiers: the energy frontier, the intensity frontier, and the cosmic frontier.
- **Nuclear Physics (NP)** supports research to discover and understand various forms of nuclear matter, as well as the production and development of techniques to make isotopes needed for medical, national security, environmental, and other research applications.

Department of Energy (DOE) Office of Science Spending
(dollars in millions)

Program	FY 2012	FY 2013 Annualized CR	FY 2014 Request	FY 2014 House Energy & Water Mark
Office of Science				
Advanced Scientific Computing Research	*428.3*	*417.8*	*465.6*	*432.4*
Basic Energy Sciences	*1644.8*	*1601.2*	*1862.4*	*1583.1*
Biological and Environmental Research	*592.4*	*578.3*	*625.3*	*494.1*
Fusion Energy Sciences	*393.0*	*380.1*	*458.3*	*506.1*
High Energy Physics	*770.5*	*748.3*	*776.5*	*772.5*
Nuclear Physics	*534.6*	*519.9*	*569.9*	*551.9*
Office of Science	***4873.6***	***4621.1***	***5152.8***	***4653.0***

SC's operations take part in three primary areas: research (44 percent in Fiscal Year 2014 budget request), facility operations (40 percent), and future facility planning (15 percent).



To carry out its mission, SC utilizes research capabilities maintained by DOE National Laboratories. The Office of Science is the steward of 10 of the 17 National Laboratories.[4] (see Appendix B) DOE laboratories are government-owned, contractor-operated facilities, that:

- "Execute long-term government scientific and technological missions, often with complex security, safety, project management, or other operational challenges;
- Develop unique, often multidisciplinary, scientific capabilities beyond the scope of academic and industrial institutions, to benefit the Nation's researchers and national strategic priorities; and
- Develop and sustain critical scientific and technical capabilities to which the government requires assured access."[5]

SC also supports research to outside stakeholders through its 31 user facilities.[6] User facilities "are among the most advanced tools of modern science, enabling researchers to explore a host of new scientific frontiers." In Fiscal Year 2014, nearly 29,000 researchers from universities, national laboratories and industry are expected to use SC scientific user facilities.[7]

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[4] For a full list of Office of Science National Laboratories see: **http://science.energy.gov/laboratories/**
[5] http://science.energy.gov/laboratories/
[6] A full list of DOE Office of Science User Facilities can be found at http://science.energy.gov/~/media/_/pdf/user-facilities/Office_of_Science_User_Facilities_FY_2013.pdf
[7] DOE FY 2014 Budget Request, Volume 4, SC-4.

Appendix A
Discussion Draft of
EINSTEIN America Act of 2013
Section by Section Analysis

Sec. 1. Short Title

This Act may be cited as the "Enabling Innovation for Science, Technology, and Energy in America Act of 2013."

TITLE I—OFFICE OF SCIENCE

Sec. 101. Mission

Section 101 codifies the basic research mission of the Office of Science as the delivery of scientific discoveries, capabilities, and major scientific tools to transform the understanding of nature and to advance the energy, economic, and national security of the United States.

Sec. 102. Basic Energy Sciences

Section 102 directs the Office of Science to carry out a basic energy sciences program, including material sciences and engineering, chemical sciences, physical biosciences, and geosciences. The Section also directs the Department to develop, construct, operate, and maintain national scientific user facilities, including x-ray light sources, neutron sources, electron beam microcharacterization centers, nanoscale science research centers, and other facilities as appropriate.

Section 102 additionally authorizes the establishment of a Light Source Leadership Initiative to sustain and advance global leadership of light source user facilities.

Sec. 103. Advanced Scientific Computing Research

Section 103 directs the Office of Science to carry out a research, development, demonstration, and commercial application program to advance computational and networking capabilities to analyze, model, simulate, and predict complex phenomena relevant to the development of new energy technologies. The Section also encourages support for applied mathematics, computer science, and advanced networking activities to support the Department's mission.

Section 103 additionally directs the Department to conduct a research and development program to pursue exascale computing systems.

Sec. 104. High Energy Physics

Section 104 directs the Office of Science to carry out a research program on the elementary constituents of matter and energy and the nature of space and time. The Department is also required to create, preserve, and maintain U.S. facilities essential to underground scientific research. The Department must deliver a report on its stewardship of underground science activities to Congress.

Sec. 105. Biological and Environmental Research

Section 105 directs the Office of Science to carry out a research, development, and demonstration program in the areas of biological systems science and climate and environmental science. The program shall prioritize fundamental research on biological systems and genomics sciences.

The Section also directs the Office of Science to carry out a research program relating to low dose radiation exposure. The National Academy of Sciences is directed to undertake an assessment of the current status of low dose radiation research. Upon completion of the report, the Department must develop a research plan in response to the assessment.

Sec. 106. Fusion Energy Science

Section 106 directs the Office of Science to carry out a fusion energy sciences research program to expand the fundamental understanding of matter at very high temperatures and densities to build the scientific foundation necessary to enable fusion power. The Section also requires the Fusion Energy Science Advisory Committee prepare and National Academy of Sciences review a plan to carry out the fusion energy sciences program.

Sec. 107. Nuclear Physics

Section 107 directs the Office of Science to carry out a program of experimental and theoretical research, and support associated facilities, to discover, explore and understand all forms of nuclear matter. The Section also directs the Department to carry out a program for the production of isotopes for research purposes.

Sec. 108. Transparency

Section 108 requires the Secretary to make public information relevant to Departmental operation and use of taxpayer funding and resources. This information includes waivers of cost share requirements for research, development, and demonstration activities under Section 988 of the Energy Policy Act of 2005; and technology transfer research agreements between National Laboratories and non-government entities.

Sec. 109. External Regulations

Section 109 directs the Secretary of Energy to coordinate with the Occupational Safety and Health Administration and the Nuclear Regulatory Commission to provide for the efficient external regulation of nuclear safety and occupational and health responsibilities at any nonmilitary energy laboratory owned or operated by the Department.

Sec. 110. Technology Transfer

Section 110 delegates signature authority to the National Laboratories for technology transfer agreements with a total cost under $500,000.

Sec. 111. National Energy Technology Laboratory.

Section 111 directs the National Academy of Public Administration to conduct a study assessing the management and operations of the National energy Technology Laboratory. The assessment shall evaluate the current status of laboratory management; assess the cost-benefit associated with operating the laboratory as a government-owned, government-operated model compared to a government-owned, contractor-operated model; and identify challenges of transitioning the laboratory to a government-owned, contractor-operated model.

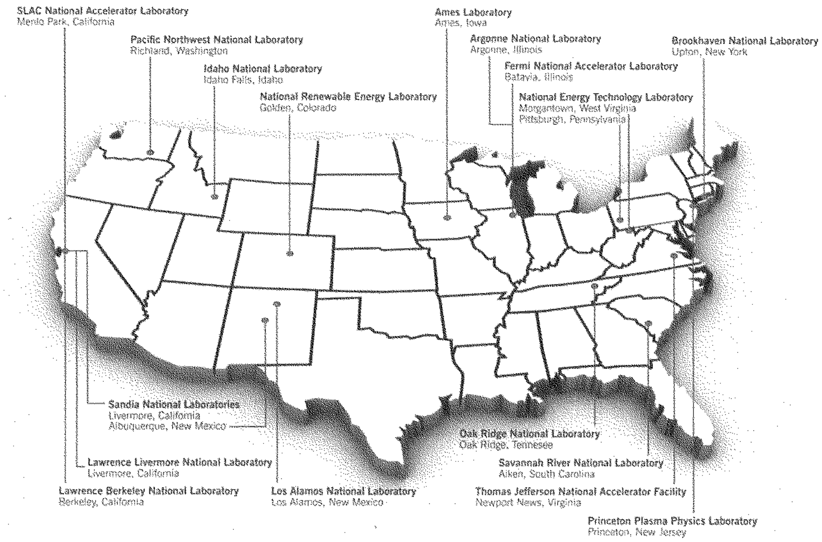
Sec. 112 Definitions.

Section 112 provides definitions, including: Office of Science, Secretary, and Under Secretary.

Sec. 113. Authorization of Appropriations

Section 111 authorizes funding for the Office of Science at $4,700 million for Fiscal Year (FY) 2014 and $4,747 million for FY 2015. The Section authorizes funding levels for the Advanced Scientific Computing Research, High Energy Physics, and Basic Energy Sciences programs.

Appendix B



DOE National Labs and Their Sponsors

Laboratory	Sponsor
Ames Lab	Science
Argonne National Lab	Science
Brookhaven National Lab	Science
Fermi National Accelerator Lab	Science
Idaho National Lab	Nuclear Energy
Lawrence Berkeley National Lab	Science
Lawrence Livermore National Lab	NNSA
National Renewable Energy Lab	Energy Efficiency and Renewable Energy
Los Alamos National Lab	NNSA
Oak Ridge National Lab	Science
Pacific Northwest National Lab	Science
Princeton Plasma Physics Lab	Science
Sandia National Lab	NNSA
Savannah River National Lab	Environmental Management
Stanford Linear Acceleration Lab	Science
Thomas Jefferson National Accelerator	Science

Chairwoman LUMMIS. Good morning. We are all scampering in to gather for this hearing that we are delighted to be holding, and we want to welcome everyone to the hearing. It is titled "Providing the Tools for Scientific Discovery and Basic Energy Research: The Department of Energy's Science Mission." In front of you are packets containing the written testimony, biographies and Truth in Testimony disclosures for today's witness panel.

Again, we are delighted that you are here, and I am going to now recognize myself for five minutes for an opening statement.

The Department of Energy is the lead Federal agency supporting fundamental scientific research for energy and the largest supporter of basic research in the physical sciences. It funds basic research at universities, owns world-class national laboratories, and makes available unique scientific user facilities to conduct groundbreaking research. These fundamental science and basic research activities provide the underpinnings of America's long-term economic competitiveness and result in scientific discoveries which change the way we look at the natural world. This scientific research has led to 113 Nobel Prize winners affiliated with the DOE or its predecessor agencies. We must continue to pursue this standard of international excellence. A vibrant scientific ecosystem fosters innovation and discovery. The Department should continue to work with its academic national lab and industry stakeholders to achieve this goal. This includes providing the tools to the national laboratories to reduce bureaucratic paperwork and regulations, as we heard in an Energy Subcommittee hearing in July. These efforts will enable taxpayers' funding to be used more efficiently.

Given the current budgetary outlook of skyrocket entitlement spending crowding out discretionary funding, it is imperative to maximize the value of limited tax dollars. DOE must prioritize its activities and assure each dollar is allocated effectively. I look forward to hearing from today's witnesses on how this can best be achieved.

[The prepared statement of Mrs. Lummis follows:]

PREPARED STATEMENT OF SUBCOMMITTEE CHAIRMAN CYNTHIA LUMMIS

Good morning and welcome to today's hearing titled Providing the Tools for Scientific Discovery and Basic Energy Research: The Department of Energy Science Mission.

The Department of Energy (DOE) is the lead federal agency supporting fundamental scientific research for energy and the largest supporter of basic research in the physical sciences. It funds basic research at universities, owns world-class National Laboratories, and makes available unique National Scientific User Facilities to conduct groundbreaking research.

These fundamental science and basic research activities provide the underpinnings of America's long-term economic competitiveness and result in scientific discoveries which change the way we look at the natural world. This scientific research has led to 113 Nobel Prize winners affiliated with DOE or its predecessor agencies. We must continue to pursue this standard of international excellence

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dollars. DOE must prioritize its activities and assure each dollar is allocated effectively. I look forward to hearing from today's witnesses on how this can best be achieved.

Chairwoman LUMMIS. Mr. Chairman, I will yield to you later, and I am delighted to recognize the Ranking Member, Mr. Swalwell, for his opening statement.

Mr. SWALWELL. Thank you, Chairman Lummis. Thank you for holding this hearing. I look forward to hearing from our distinguished panel of witnesses.

The Department of Energy's Office of Science is the Nation's largest supporter of research in the physical sciences, so it is impossible to overstate its important role that it will play in establishing our energy future and to our innovation enterprise. Our witnesses today will be able to speak in much greater detail about the Office, but I want to start by highlighting just a few of the amazing activities that this program supports.

The Basic Energy Sciences program builds and operates a number of major user facilities, including several massive light sources and neutron sources that allow us to examine new materials and to watch fundamental chemical and biological processes almost in real time. About 14,000 researchers across the country use these facilities each year. These users include not only Department of Energy scientists, but university scientists as well as their students, as well as researchers from approximately 160 companies including names like Boeing, Dow, Ford, General Electric, IBM, Merck, and Pfizer. I would be remiss if I didn't also mention that this program supports the Combustion Research Facility at Sandia National Laboratory, which has been working closely with U.S. engine manufacturers for more than 30 years to improve efficiency and reduce harmful emissions from internal combustion engines.

As we touched on in a hearing earlier this year, the Office's Advanced Computing Research program is supporting facilities and developing software tools that address our scientific community's major supercomputing needs today, and it is providing the scaffolding necessary to build the next generation of high-end computing systems for tomorrow. This capacity will enable researchers across the scientific arena, from materials science to climate change to astrophysics, to acquire unparalleled accuracy in their simulations and achieve research breakthroughs more rapidly than ever before.

This is why I am pleased to be an original cosponsor of the bipartisan American Super Computing Leadership Act recently introduced by my colleague on the Science Committee, Mr. Hultgren, and I am encouraged to see its language incorporated in various versions of a reauthorization of the Office of Science.

The Fusion Energy Sciences program supports research into plasma physics and the underlying engineering challenges of fusion energy systems. If successful, these efforts would provide us with a practically inexhaustible source of energy with almost zero environmental impact. And the Nuclear and High Energy Physics programs allow us to make discoveries from the atomic all of the way up to the cosmic level, engaging human beings' innate curiosity about the origin and makeup of our universe and our place in it. I could spend my entire opening statement talking about the great

research supported by the Office of Science, but I will spare all of you that.

It is important to note that many of these programs and activities would not be possible without the world-class system of national laboratories supported by the Office. These labs are rightfully described as the backbone, or crown jewels, of our country's research and development infrastructure. They house facilities and provide capabilities that are impossible for academic or industrial research institutions to support on their own, and we know that they won't. They employ some of the world's brightest scientists and engineers, and they help train our country's next generation of researchers. I may be a bit partial toward the labs because I happen to have two in my district, Sandia and Lawrence Livermore, and just about a three-iron away is the Lawrence Berkeley Laboratory, where Dr. Simon comes from, and we will talk about shortly, but without a doubt, the research and technologies that come out of these labs have produced an immense return on investment for American taxpayers.

Unfortunately, the funding levels in the draft legislation that the majority is asking us to consider are simply inadequate to allow the Office of Science to continue to support the great research and facilities that it does. At a first glance, one might believe that the majority's bill actually increases funding for the Office, but a closer look reveals that it is actually a cut to the funding because the rate of inflation for research is approximately three percent annually, but the bill only provides year-to-year increases of 1 to 1.7 percent. In effect, it is a cut to the Office's budget. I hope that we can work around this, increase the budget and give the Office of Science the research and funding that it deserves.

We hear a lot of talk about America being the greatest country in the world. I certainly believe that, and it certainly is, but if want to maintain our leadership and standing in technology and innovation and the jobs that will come with it, we can't afford to continue to cut our research budgets, cede leadership on important areas like fusion to China and Russia without any consideration of the impacts such cuts will have on our Nation's competitiveness.

I look forward to discussing these and other issues with this distinguished panel here, and Madam Chairman, I yield back the balance of my time.

[The prepared statement of Mr. Swalwell follows:]

PREPARED STATEMENT OF SUBCOMMITTEE RANKING MEMBER ERIC SWALWELL

Thank you Chairman Lummis for holding this hearing, and I also want to thank this excellent panel of witnesses for their testimony and for being here today.

The Department of Energy's Office of Science is the nation's largest supporter of research in the physical sciences, so it is impossible to overstate its importance to our energy future and to our innovation enterprise. Our witnesses will be able to speak in much greater detail about the Office, but I want to start by highlighting just a few of the amazing activities and programs that it supports.

The Basic Energy Sciences program builds and operates a number of major user facilities, including several massive light sources and neutron sources that allow us to examine new materials and to watch fundamental chemical and biological processes in almost real-time. About 14,000 researchers use these facilities each year. These users include not only DOE scientists, but university scientists and their students, as well as researchers from roughly 160 private companies including names like Boeing, Dow, Ford, General Electric, IBM, Merck, and Pfizer. I'd be remiss if I didn't also mention that this program supports the Combustion Research Facility

at Sandia National Laboratories, which has been working closely with U.S. engine manufacturers for more than 30 years to improve efficiency and reduce harmful emissions from internal combustion engines.

As we touched on in a hearing earlier this year, the Office's advanced computing research program is supporting facilities and developing software tools that address our scientific community's major supercomputing needs today, and it is providing the scaffolding necessary to build the next generation of high-end computing systems tomorrow. This capacity will enable researchers across the scientific arena, from materials science to climate change to astrophysics, to acquire unparalleled accuracy in their simulations and achieve research breakthroughs more rapidly than ever before. This is why I am pleased to be an original co-sponsor of the bipartisan American Super Computing Leadership Act recently introduced by Mr. Hultgren, and I am encouraged to see its language incorporated in various versions of a reauthorization of the Office of Science.

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It's important to note that many of these programs and activities would not be possible without the world-class system of national labs supported by the Office of Science and other offices at DOE. These labs are rightfully described as the backbone, or the "crown jewels," of our country's R&D infrastructure. They house facilities and provide capabilities that are impossible for academic or industrial research institutions to support on their own. They employ some of the world's brightest scientists and engineers. And they help train our country's next generation of researchers. I may be a bit partial toward the labs because I happen to have one or two in my district (and a few more nearby, as Dr. Simon may rightfully point out) but, without a doubt, the research and technologies that come out of these labs have produced an immense return on investment to American taxpayers.

Unfortunately, the funding levels in the draft legislation that the Majority is asking us to consider are simply inadequate to allow the Office of Science to continue to support the great research and facilities that it does. At first glance, one might think that the Majority's bill actually increases funding for the Office, but a closer look reveals that they are actually cutting funding—the rate of inflation for research is about three percent, but the bill only provides year-to-year increases of 1 to 1.7 percent, in effect cutting the Office's budget. This is simply unacceptable and seems to be a pattern on this Committee. We hear a lot of talk about America being the greatest country in the world, and it certainly is, but if want to maintain our leadership in technology and innovation—and the jobs that come with it—we can't afford to continue to cut our research budgets without any consideration of the impacts such cuts will have on our nation's competitiveness.

I look forward to discussing these and other issues with this distinguished panel here today, and with that I yield back the balance of my time.

Chairwoman LUMMIS. I thank the Ranking Member and now recognize the Chairman of the full Committee on Science, Space, and Technology, the gentleman from Texas, Mr. Smith.

Chairman SMITH. Thank you, Madam Chair, and I also want to thank you for your statement and the Ranking Member for his statement, which I thought was largely positive, and I appreciate that. We may have a slight difference on funding but I think overall we all are very encouraged by what the Office of Science at the DOE does.

The Department of Energy at its core is a science agency. Its science mission is carried out through its basic research activities executed by the Office of Science. This research provides the foundation for innovation that drives long-term economic growth and serves as a valuable investment in America's future.

The impact of DOE basic research activities is evident in our daily lives. Thousands of lives have been saved by DOE-sponsored research that developed MRIs and noninvasive cancer detection methods. Technological revolutions such as smaller, faster computer processors and breakthrough discoveries in energy storage can be traced to DOE basic research programs.

Today's hearing will focus on draft legislation titled "Enabling Innovation for Science, Technology, and Energy in America Act," or EINSTEIN America Act. Yes, we like acronyms. The EINSTEIN America Act supports high-impact research that promotes economic innovation and revolutionary scientific research such as the development of X-ray light sources and high-performance computing programs. It recognizes the role of discovery science programs which explore the most fundamental questions about the nature of the universe.

The discussion draft requires the Department of Energy to coordinate with other Federal agencies to streamline workplace regulations. This reduces burdensome red tape and provides the national labs flexibility to more effectively and efficiently execute the Department's mission. This ensures that American taxpayer dollars are better utilized and enables labs to do more with less. The EINSTEIN America Act prioritizes science activities within the Department. It provides for an almost two percent increase above current spending levels.

The discussion draft and today's hearing serve as a starting point in the legislative process. I look forward to the witnesses' testimony and to working with Committee Members to advance this bill.

Thank you, Madam Chairman, and yield back the balance of my time.

[The prepared statement of Mr. Smith follows:]

PREPARED STATEMENT OF COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY CHAIRMAN LAMAR S. SMITH

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The EINSTEIN America Act prioritizes science activities within the Department. It provides for an almost two percent increase above current spending levels and

a one percent increase above the House-passed appropriations level for Fiscal Year 2014.

The discussion draft and today's hearing serve as a starting point in the legislative process. I look forward to the witnesses' testimony and to working with Committee Members to improve and advance this draft bill.

Thank you and I yield back the remainder of my time.

Chairwoman LUMMIS. Thank you, Mr. Chairman, and now the Chair recognizes the Ranking Member of the full Committee, the gentlelady from Texas, Mrs. Johnson.

Ms. JOHNSON. Thank you very much. Thank you, Madam Chair, for holding this hearing today, and I would like to thank the witnesses as well for being here.

The Department of Energy's Office of Science is actually the largest supporter of basic research in the physical sciences in the country, and it operates more than 30 national scientific user facilities whose applications go well beyond energy innovation. Our Nation's top researchers from industry, academia and other Federal agencies use these facilities to examine everything from new materials that will better meet our military's needs, to new pharmaceuticals that will better treat disease, or even to examine the fundamental building blocks of the universe. I believe that this stewardship of unique scientific research, including the Nation's major national user facilities, is an important role that I hope the Department will continue to make one of its highest priorities.

I appreciate the majority's efforts today to shine a spotlight on the good work carried out by the Office of Science and to authorize many of its important programs. However, I do have some significant concerns about the funding levels in the majority's discussion draft, which essentially amount to harmful cuts because they do not even keep up with the rate of inflation for research. These levels for Fiscal Year 2014 are actually less than the Senate Appropriations Mark and the Administration's request levels by almost nine percent. I am also concerned with the language that is clearly aimed at shifting support away from critical activities that the Office carries out to examine the science and impacts of climate change.

That said, I believe there is common ground in our support for many of the Office's programs. Yesterday I was pleased to circulate a discussion draft of the America COMPETES Reauthorization Act of 2013, produced by my staff, which includes several similar provisions to the majority's draft. It also includes authorization for the Advanced Research Projects Agency for Energy and a number of important legislative changes that would accelerate technology transfer and improve the management of our national laboratories.

With these two drafts in mind, I look forward to working with the majority and the science and technology community to seek out that common ground and to see if the concerns that I have raised can be reconciled.

I thank you, Madam Chair, and I yield back the balance of my time.

[The prepared statement of Ms. Johnson follows:]

PREPARED STATEMENT OF COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY RANKING MEMBER EDDIE BERNICE JOHNSON

Thank you Chairman Lummis for holding this hearing today, and I would also like to thank the witnesses for being here.

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With these two drafts in mind, I look forward to working with the Majority and the science and technology community to seek out that common ground, and to see if the concerns that I've raised can be reconciled.

Chairwoman LUMMIS. I thank the gentlelady.

If there are Members who wish to submit additional opening statements, your statements will be added to the record at this point.

At this time I would like to introduce our witnesses. Our first witness today is Dr. Patricia Dehmer, Deputy for Science Programs at the Office of Science, Department of Energy. Previously, she served as the Deputy Director for Science Programs at DOE. From 1995 to 2007, she served as the Director of the Office of Basic Energy Sciences at DOE. She also started her career at DOE as a postdoctoral fellow at Argonne National Laboratory in 1972. Welcome, Dr. Dehmer.

I would also now like to yield to the gentleman from California, the Ranking Member of the Subcommittee, Mr. Swalwell, to introduce our second witness.

Mr. SWALWELL. Thank you, Chairman Lummis.

Today I am very pleased to introduce Dr. Horst Simon, Deputy Director at Lawrence Berkeley National Laboratory. Dr. Simon joined the laboratory in early 1996 as the Director of the National Energy Research Science Computing Center, and under his leadership, the Center enabled important discoveries for research in fields ranging from global climate modeling to astrophysics. Dr. Simon is an internationally recognized expert in computer science and applied mathematics, and he received the Gordon Bell Prize for Parallel Processing Research twice, first in 1988 and again in 2009. He was also a member of the team that developed NASA's

Advanced Supercomputing Parallel Benchmarks, a widely used standard for evaluating the performance of massively parallel computing systems. Dr. Simon holds an undergraduate degree in mathematics and a Ph.D. in mathematics from the University of California at Berkeley, clearly a great university, given how close it is to the 15th Congressional District.

I also should personally note that during my last visit to Lawrence Berkeley Laboratory, as I was nearing the end of the tour and had to go to another meeting, Dr. Simon had the unfortunate distinction of drawing the shortest straw, and his presentation was at the very end, and he was following me all the way out to the parking lot. He was so excited about the research and what he was working on. I am happy to continue listening to you, Dr. Simon, by inviting you here to testify today in Congress, and I really appreciate the work you do for the Bay Area and the international science community.

Thank you, and I yield back.

Chairwoman LUMMIS. I thank the gentleman. It appears your enthusiasm is infectious, and you have infected the Ranking Member of this Committee with your enthusiasm, and we appreciate that very much, Dr. Simon.

Our third and final witness today is Dr. John Hemminger, Chairman of the Basic Energy Science Advisory Committee for the Department of Energy. Dr. Hemminger is the Vice Chancellor for Research and a Professor of Chemistry at the University of California Irvine.

Now, as our witnesses should know, spoken testimony is limited to five minutes each after which the Members of the Committee will have five minutes each to ask questions.

Okay. We are ready to begin. I now recognize Dr. Dehmer for five minutes to present her testimony. Welcome, Dr. Dehmer.

TESTIMONY OF DR. PAT DEHMER, DEPUTY DIRECTOR FOR SCIENCE PROGRAMS, OFFICE OF SCIENCE, DEPARTMENT OF ENERGY

Dr. DEHMER. Thank you so much, Chairman Lummis, Ranking Member Swalwell and Members of the full Committee and the Subcommittee. I am pleased to be here today to represent DOE's Office of Science, often called the best-kept secret in town.

For more than six decades, the Office of Science and its predecessors have been a U.S.and world leader in scientific discovery and innovation. We have led the world in high-performance computing. We helped drive the transition from using only those materials that are found in nature to the directed design of new materials at the atomic level. We have played an important role in initiating the modern biotechnology revolution through the creation of the Human Genome Project. We have pushed the frontiers of understanding the origins of matter and the universe, and we have built and operated dozens of large-scale scientific user facilities, which are major pillars of the U.S. scientific enterprise. Today they serve 29,000 users annually. From the earliest accelerators in the 1930s to today's supercomputers and the Linac Coherent Light Source, the world's first hard X-ray laser, these facilities have redefined what is possible over and over again.

As the Federal agency funding the largest fraction of basic research in the physical sciences, we need to continue to provide the scientific research community with the tools and opportunities for the future. Here are half a dozen or so areas of priority for us. The first is high-performance computing. No other nation has been as successful in scientific computing as the United States. The United States has more supercomputers on the list of top 500 machines than any other nation and it has held this advantage since the list was first compiled in 1993, but our lead is precarious. To retain this lead, we are planning the next phase in high-performance computing, sometimes known as exascale computing, or the Exascale Initiative. This is not simply a machine capable of ten to the eighteenth operations per second. Rather, it is a journey to a new level of predictive design using computation. This will require advances in applied math, computer science, manipulation of big data, and the development of community codes so that we are ready on day one and that we are ready to be the first to benefit from these new machines.

The second area is predictive design of materials. The energy systems of the future, whether they tap sunlight, store electricity or make fuel by splitting water, will involve materials that convert energy from one form to another. New materials will require exquisite control and functionality and they must be synthesized with precisely defined atomic arrangements. Of critical importance in doing this are our major scientific user facilities that probe materials at the atomic level, and these are the big light sources, the neutral scattering facilities and the electron beam scattering facilities.

As a partner to predictive design of materials is predictive design of biological systems. Understanding how genomic information is translated into functional capabilities will enable design of microbes and plants for sustainable biofuels production, improved carbon storage and biological transformation of materials such as nutrients and contaminants in the environment.

Next in line is scientific discovery and technology innovation through new funding constructs, often employing what we call team science. Examples are the Bioenergy Research Centers, now in their second five-year term, the Energy Frontier Research Centers and the Energy Innovation Hubs.

Next is earth systems modeling. As a major supporter of the leading U.S. climate model, the Community Earth Systems Model, we recognize that today's models must be significantly improved to modernize the code, make the code compatible with our advanced high-performance computers, incorporate realistic biogeochemical systems—that is atmosphere, land, ocean, sea ice and subsurface—improve resolution and improve uncertainty quantification.

Next is the fundamental nature of matter of energy. This is high-energy physics and nuclear physics. Understanding how the universe works by studying the properties and constituents of matter and energy, largely through the use of advanced accelerators and detectors, has been the responsibility of the Office of Science since the 1930s. Our scientific reach has now expanded through incorporation of underground science and cosmic science. In addition, we

have taken on two new roles: stewardship of accelerator R&D for the Nation, and the Isotope Production program.

Finally, the last important priority for us is harnessing plasmas, the fourth state of matter. Controlling matter at very high temperatures and densities builds the scientific foundation needed to develop a fusion energy source.

Thank you, Chairman and Members. I would be pleased to answer your questions.

[The prepared statement of Dr. Dehmer follows:]

Statement of the Acting Director of the Office of Science, Patricia Dehmer

U.S. Department of Energy

Committee on Space, Science, and Technology

U.S. House of Representatives

October 30, 2013

Thank you Chairman Lummis, Ranking Member Swalwell, and members of the Subcommittee. I am pleased to represent the Department of Energy (DOE) Office of Science at this hearing to discuss the role of the Office of Science in providing tools for scientific discovery and basic energy research.

The DOE Office of Science has long been a leader of U.S. scientific discovery and innovation. Over the decades, the Office of Science has pushed the frontiers of understanding of the origins of matter and the universe; the Office Science has led the world in high performance computing and simulation; we have helped drive the transition from observing natural phenomena to the science of control and directed design at the nanoscale; the Office of Science has played an important role in initiating the modern biotechnology revolution through the initiation of the Human Genome Project; and the Office of Science has built and operated the large-scale scientific facilities that collectively form a major pillar of the current U.S. scientific enterprise. As the federal agency funding the largest fraction of basic research in the physical sciences, the Office of Science will continue to pursue scientific discoveries that provide the technological foundation to extend our understanding of nature and to enable new technologies that support DOE's energy, environment, and security missions.

Today, the Office of Science looks to the future by building on both our historic strengths and unique assets. The Office of Science conducts mission-focused research that employs the capabilities of the national laboratories, universities, and industry to deliver scientific breakthroughs and extend the Nation's knowledge of the natural world.

The Office of Science supports more than 30 national scientific user facilities, which provide researchers with the most advanced tools of modern science, including accelerators, detectors, colliders, supercomputers, light sources and neutron sources, and facilities for studying the nanoworld, the environment, and the atmosphere. Today, about 29,000 researchers from academia, industry, and government laboratories, spanning all fifty states and the District of Columbia, use these facilities to perform scientific research. The Office of Science continues to build on its legacy of excellence in creating and operating world-class, large-scale scientific tools. From the earliest accelerators to the new Linac Coherent Light Source, these facilities continue to redefine what is possible.

The Office of Science is also responsible for the oversight of 10 of DOE's 17 national laboratories: Ames Laboratory, Argonne National Laboratory, Brookhaven National Laboratory, Fermi National Accelerator Laboratory, Lawrence Berkeley National Laboratory, Oak Ridge National Laboratory, Pacific Northwest National Laboratory, Princeton Plasma Physics Laboratory, SLAC National Accelerator Laboratory, and Thomas Jefferson National Accelerator Facility.

Together, these laboratories comprise a preeminent federal research system, providing the Nation with strategic scientific and technological capabilities. The laboratories execute long-term scientific and

technological missions, often with complex security, safety, project management, or other operational challenges; develop unique, often multidisciplinary, scientific capabilities beyond the scope of academic and industrial institutions; and develop and sustain critical scientific and technical capabilities to which the government requires assured access. These laboratories also play the major role in the design, construction, and operation of the world-leading facilities and research tools described above.

The DOE laboratories complement the roles and capabilities of the Nation's academic and industrial research efforts—they collaborate with universities in fundamental and applied research, and they partner with industry in technology development and deployment to aid the transfer of R&D to the marketplace.

Secretary Moniz recently created the National Laboratory Policy Council (NLPC) and the National Laboratory Operations Board (NLOB) to strengthen the partnership between the department and the laboratories. The NLPC provides a forum for Laboratory and Departmental leadership to improve laboratory strategic direction and program planning. Early topics addressed by the NLPC are expected to include accessibility of research facilities, support of technology transfer, and an enhanced role for the laboratories in addressing national priorities. The NLOB will focus on complex-wide management issues and is expected to provide input on developing, improving, and implementing effective and streamlined management and operations.

Secretary Moniz also approved a top-level reorganization of the Department that reallocates the responsibilities of the Department's three Offices of Under Secretary. This reorganization will improve integration of the science and applied energy R&D programs of the Department by establishing an Under Secretary for Science and Energy; will improve project management and increase the effectiveness and efficiency of our mission support functions across the Department by establishing an Under Secretary for Management and Performance; and will establish an enterprise-wide vision and coordination of major cross-cutting programs. The Under Secretary for Nuclear Security will oversee the National Nuclear Security Administration.

One aspect of this reorganization combines the energy and science programs of the department under a single Under Secretary for Science and Energy to include the energy technology portfolio, resulting in establishment of the Office of the Under Secretary for Science and Energy. This enables closer integration of basic science, applied research, and technology demonstration. This new position will enable DOE to build on existing collaborations between basic and applied sciences. For example, more than half a dozen "tech teams" serve as an ongoing mechanism for Secretary Moniz and the new office of the Under Secretary for Science and Energy to drive integration and bring together program managers in areas such as advanced computing, the electric grid, and energy storage. For further details, the Office of Science FY 2014 budget request details R&D coordination for each of our six program areas. Additionally, we are currently exploring other areas that would benefit from cross cutting science and technologies collaboration.

Today, the Office of Science focuses on strategic areas inspired by the most compelling scientific opportunities. Our six program areas collaborate and leverage the knowledge and experience of one another. Expertise in accelerator physics that started in High Energy Physics program now enables the synchrotron radiation light sources in the Basic Energy Sciences program. Climate modeling activities in the Biological and Environmental Research program benefit from atmospheric measurements in that same program and, also, from the high performance computing facilities supported by the Advanced

Scientific Computing Research Program. The following sections summarize current Office of Science activities in the six program offices.

ADVANCED SCIENTIFIC COMPUTING RESEARCH (ASCR)

The ASCR program supports mathematical, computational, and computer sciences research as well as high performance computing and network facilities. This research develops and deploys computational and networking capabilities to analyze, model, simulate, and predict complex phenomena.

No other nation has been as successful in scientific computing and innovation as the United States (U.S.). The U.S. has more supercomputers on the list of the 500 world's most advanced machines than any other nation–and it has held this advantage since the first such list was compiled in 1993. In large part, the U.S. owes its advantage to a longstanding and strategic effort by its universities, high-tech industries, and federal science agencies, in particular the Department and its national laboratory complex. These groups have pushed the boundaries of computing to support economic growth, quality of life, and national security. High performance computing and large data systems are now a mainstay for U.S. strategic industries. But our lead is not guaranteed, and maintaining it will require innovation and effective stewardship.

The National Energy Research Scientific Computing Center (NERSC) is the primary high performance scientific computing resource for researchers supported by the DOE Office of Science. NERSC-7 is a Cray XE6 with a peak theoretical performance of 1.29 Petaflop/s(or over 100 trillion operations per second). NERSC supports the largest and most diverse research community of any computing facility within the DOE complex. In 2012, over 600 projects ran at NERSC.

The Oak Ridge Leadership Computing Facility (OLCF) operates a 27 petaflop system, which is one of the most powerful computers in the world for scientific research according to the June, 2013 Top 500 list. The Argonne Leadership Computing Facility (ALCF) operates a 10 petaflop machine with relatively low electrical power requirements. In order to maximize the potential of these machines, the Office of Science requires that a large portion of the computing resources be devoted to jobs that require more than 20 percent of the computational resources of a given facility. The lessons learned about large-scale computing systems and user support inform NERSC and others about how to broaden and extend the impact of advanced scientific computing to the wider research community.

The Energy Sciences Network (ESnet) is a high-speed network optimized for the support of large-scale scientific research. ESnet interconnects the entire national laboratory complex, including its supercomputer centers and all user facilities. ESnet provides direct connections to more than 40 DOE sites at speeds up to 100 gigabits per second. ESnet differs from traditional providers of network services because massive science data flows require different handling than small flows generated on the global Internet.

ASCR, in collaboration with the NNSA, is pursuing the research necessary to enable and build the next-generation of supercomputers. These exascale machines (i.e., computing on order of 10^{18} operations per second and order of 10^{18} bytes of storage) will extend capability significantly beyond today's petascale computers to address next-generation problems in science, engineering, and large data. It is anticipated the exascale effort also will set the U.S. on a design trajectory of a broad spectrum of capabilities that will expand the use of terascale and petascale computing to smaller organizations, businesses, and individuals. This will require new technology advances, the most important of which involve advances in parallelism, the speed of memory access, and energy efficiency that are needed for

scalable computing systems capable of greatly improved performance with acceptable power requirements. These research investments will impact computing at all scales from the largest scientific computers and data farms to Department-scale computing to home computers and laptops.

BASIC ENERGY SCIENCES (BES)

The BES program supports fundamental research to understand, predict, and ultimately control matter and energy at the electronic, atomic, and molecular levels in order to provide the foundations for new energy technologies and to support DOE missions in energy, environment, and national security.

The disciplines that BES supports—condensed matter and materials physics, chemistry, geosciences, and aspects of physical biosciences—are those that discover new materials and design new chemical processes to address important aspects of energy resources, production, conversion, transmission, storage, efficiency, and waste mitigation. The energy systems of the future—whether they tap sunlight, store electricity, or make fuel by splitting water or reducing carbon dioxide—will revolve around materials and chemical changes that convert energy from one form to another. Key to these energy systems will be new materials created using advanced synthesis and processing techniques coupled with high performance computational modeling that precisely predicts the atomic arrangements in materials. These advanced materials must be designed and fabricated to exacting standards.

The BES program also designs, constructs, and operates major scientific user facilities that provide researchers access to unique tools to advance a wide range of sciences, including chemistry, physics, geology, materials science, environmental science, biology, and biomedical science. These facilities enable the study of matter at the level of atoms and molecules, and employ instruments that can probe structures that are one thousand times smaller than those detectable by the most advanced light microscopes.. These probes, which are x-rays, electrons, and neutrons, provide unique capabilities to help understand the fundamental aspects of the natural world. A wide range of industries have found these facilities critical to product and process development. The facilities are operated on an open access, competitive merit review basis and serve more than 13,000 users each year.
The BES program also supports 46 Energy Frontier Research Centers (EFRCs) and two Energy Innovation Hubs (Hubs). These funding activities have a common theme—they are new approaches to accelerate the pace of discovery and innovation. EFRCs are based on community-identified basic research needs to advance areas of energy technology. These centers have demonstrated the power of small-team science that helps drive discovery and innovation beyond what individual investigators might accomplish. After four years, the 46 EFRCs have produced 3,800 peer-reviewed journal papers, 200 patent applications, 60 patent/invention disclosures, and 30 licenses for EFRC technologies. EFRC graduate students and staff have gone on to positions in industry, academia, and national laboratories. In FY 2014, an open recompetition is scheduled for the EFRCs.

The BES program supports two of the DOE five Hubs. The Hubs are intended to address technical challenges that require large, multi-institutional, multi-disciplinary efforts to dramatically advance technology in their areas; this might mean moving from discovery to prototypical technology or from early stage technology to commercial viability. The Hubs require strong leadership to shift research directions when needed. The two Hubs supported by the BES program are: (1) the Joint Center for Artificial Photosynthesis, established in September 2010, which focuses on advances in the development of artificial photosynthetic systems for converting sunlight, water, and carbon dioxide into a range of commercially useful fuels, and (2) the Joint Center for Energy Storage Research, established in

December 2012, which focuses on the fundamental performance limitations for electrochemical energy storage—beyond lithium ion batteries—relevant to both the electricity grid and transportation.

BIOLOGICAL AND ENVIRONMENTAL RESEARCH (BER)

The BER program supports fundamental research and scientific user facilities to achieve a predictive understanding of complex biological, climatic, and environmental systems. A hallmark of activities in recent years has been the integration within and between the disciplines of biological sciences and environmental sciences to address major issues in sustainable energy.

The BER-supported research uncovers nature's secrets from the diversity of microbes and plants to how entire biological systems work, how they interact with each other, and how they can be manipulated to harness their processes and products. Understanding how genomic information is translated into functional capabilities enables redesign of microbes and plants for sustainable biofuels production, improved carbon storage, and understanding the biological transformation of materials such as nutrients and contaminants in the environment. The DOE Joint Genome Institute remains an essential component for BER's systems biology efforts, providing high-quality genome sequence data to the research community and developing future capabilities to manipulate and synthesize DNA in support of biofuels, biodesign, and environmental research.

Today, the tools of plant and microbial systems biology are being used at the three DOE Bioenergy Research Centers (BRCs) to address barriers to the design and production of next-generation biofuels from non-food plant biomass. As forerunners of the Hubs, the BRCs expand scientific knowledge, starting with research needed to overcome the barriers to cellulosic biofuels. Like Hubs, the BRCs are large, multi-institutional and multi-disciplinary centers. They have strong leadership that has demonstrated flexibility to shift research directions as needed. As the BRCs have matured—they are in their second five-year award term—they have further advanced basic research and are partnering with the DOE technology offices and industry to help develop technology based on scientific discovery.

The BER program also supports modeling and experimental research to understand the roles of the Earth's biogeochemical systems (the atmosphere, land, oceans, sea ice, and subsurface) in determining climate in order to predict climate decades or centuries into the future, information needed to plan for future energy and resource needs.

As a major supporter of the Community Earth System Model (CESM), a leading U.S. climate model, BER research seeks to improve today's climate models by gaining a more accurate understanding of climate processes, including addressing two of the most critical areas of uncertainty in climate science—the impacts of clouds and aerosols. BER's Atmospheric Radiation Measurement Climate Research Facility (ARM) provides long-term land-based atmospheric observation and measurement data that is used by over a thousand scientists worldwide to study the impact of evolving clouds, aerosols, and precipitation on the Earth's radiative balance. A major goal of this work is quantifying and reducing the uncertainties in Earth system models based on advanced model development, diagnostics, and climate system analysis. Priority model components include the ocean, sea-ice, land-ice, aerosols, atmospheric chemistry, terrestrial carbon cycling, multi-scale dynamical interdependencies, and dynamical cores.

BER also supports research to understand the impacts of climate change (e.g. warmer temperatures, changes in precipitation, increased levels of greenhouse gases, and changing distributions of weather extremes) on different ecosystems such as forests, grasslands, and farmland. BER's Integrated

Assessment Program seeks to understand and describe the role of human activity (e.g., existing energy infrastructures, proposed renewable infrastructures, related water infrastructures, etc.) as an interdependent component of the regional climate and earth system, with a view to define system dynamical thresholds and tipping points, larger scale impacts, and possible mitigation strategies. Finally, BER research seeks understanding of the critical role that biogeochemical processes play in controlling the cycling and mobility of materials (e.g., carbon and other nutrients) in the Earth's subsurface and across key surface-subsurface interfaces in the environment.

HIGH ENERGY PHYSICS (HEP)

The HEP program supports research to understand how the universe works at its most fundamental level by investigating the elementary constituents of matter and energy, probing the interactions among them, and exploring the basic nature of space and time.

Today, particle physics is described by the Standard Model, a successful model of the elementary particles that make up ordinary matter—the matter that we can see—and the forces that govern them. However, astronomical observations indicate that ordinary matter makes up only about 5% of the universe, the remainder being dark energy and dark matter, both "dark" because they are either nonluminous or unknown. Neither is described by the Standard Model. The observation of very small but non-zero masses of the elementary particles known as neutrinos provides further hints of yet-to-be-understood physics beyond the Standard Model. A world-wide research program is underway to discover what lies beyond the Standard Model.

The HEP program explores these questions using a variety of tools and theories, which are described in three topical areas: the Energy Frontier, the Intensity Frontier, and the Cosmic Frontier. These are described below, each with an example of a key experiment. HEP continues to gather community input on possible future facilities via the Particle Physics Project Prioritization Panel—a subcommittee of the federal High Energy Physics Advisory Committee—that was charged in September, 2013 to assess current and future scientific opportunities over the next 20 years and recommend facilities that are best suited to address these opportunities.

The Energy Frontier uses the highest energy accelerators available to create particles never before seen in the laboratory, revealing their interactions and investigating fundamental forces. In 2012, HEP researchers at the Large Hadron Collider at CERN in Switzerland participated in the observation of the long-sought-after Higgs boson.

The Intensity Frontier uses intense particle beams, massive detectors, and/or high precision detectors to investigate fundamental forces and particle interactions by studying events that occur only rarely in nature. The NOvA neutrino experiment and detector contains the world's most intense neutrino beam; the goals of this experiment include improved measurements of neutrino properties. Other experiments at Fermilab will probe energy scales beyond those achievable at the LHC through the study of rare processes and precision measurements.

The Cosmic Frontier uses advanced telescopes and underground detectors to measure astrophysical phenomena that provide information about the nature of dark matter and dark energy. The *Large Synoptic Survey Telescope Camera (LSSTcam)* is a digital camera for the ground-based optical and near-infrared LSST observatory, located in Chile. LSST will provide deep images of half the sky every few nights. It will address a broad range of astronomical topics with an emphasis on precision studies of the

nature of dark energy. The project is in collaboration with the National Science Foundation and private and foreign contributions. DOE will provide the camera for the facility.

HEP is also the steward of accelerator R&D technology for DOE. This extends accelerator science research to other fields of science and to R&D in specific technological areas, such as high-power lasers. Many of the advanced technologies and research tools originally developed for HEP have proven widely applicable to other sciences as well as industry, medicine, and national security.

NUCLEAR PHYSICS (NP)

The NP program supports research to discover, explore, and understand all forms of nuclear matter. The fundamental particles that compose nuclear matter—quarks and gluons—are themselves relatively well understood; however, the manner in which they interact and combine to form the different types of matter observed in the universe today and during its evolution remains largely unknown. In the quest to understand the properties of different forms of nuclear matter, NP supports both theoretical and experimental research. Theoretical approaches are based on a description of the interactions of quarks and gluons using a theory known as Quantum Chromodynamics.

The NP program also operates the Isotope Development and Production for Research and Applications activity (Isotope Program), which supports the production, distribution, and development of production techniques for radioactive and stable isotopes in short supply and critical to the Nation. The goals of the program are to make key isotopes more readily available to meet U.S. needs and to support R&D for developing new and more cost-effective and efficient production and processing techniques.

User facilities and their associated equipment account for about half of the NP program. Three national scientific user facilities are supported: the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory; the Continuous Electron Beam Accelerator Facility (CEBAF) at Thomas Jefferson National Accelerator Facility; and the Argonne Tandem Linac Accelerator System at Argonne National Laboratory. These facilities serve more than 3,000 users each year. In addition, the planned Facility for Rare Isotope Beams (FRIB) is scheduled to begin construction at Michigan State University in FY 2014.

The RHIC facility, which began operations in 2000, remains the only collider in the world with dedicated running for heavy ion research (the CERN Large Hadron Collider runs heavy ions about one month per year), and it is the only polarized proton collider ever built. RHIC collides all ion beam species from protons to uranium. Two concentric accelerator rings 2.4 miles in circumference containing a total of 1700 superconducting magnets afford RHIC the capability to independently accelerate and collide different beam species and, for protons, different spin polarizations. RHIC is used by about 1,200 DOE, NSF, and international researchers each year.

CEBAF provides beams of polarized electrons for the study of quark and gluon structure of protons and neutrons. In 2012, CEBAF began an 18 month shut down to implement a major upgrade that will double the maximum energy to 12 GeV, upgrade instruments, and add a new experimental hall for research on exotic mesons. CEBAF is an unique scientific user facility with unparalleled capabilities world-wide using polarized electron beams to study the contributions of quarks and gluons to the properties of hadrons.

FRIB will provide intense beams of rare isotopes for research in nuclear structure, nuclear astrophysics, and fundamental symmetry studies to advance knowledge of the origin of the elements and the evolution of the cosmos. FRIB will allow research on many thousands of exotic nuclear species, most of

which have never existed before or are only fleetingly created in the hot interiors of stars. As a result, FRIB will provide opportunities to test the predictive power of models by extending experiments to new regions of mass and proton-to-neutron ratio and to identify new phenomena that will challenge the existing many-body theory. FRIB offers the possibility that a broadly applicable theory of the structure of nuclei will emerge. It will offer new glimpses into the origin of the elements by providing better insight into the structure of exotic nuclei that, until now, have been created only in nature's most spectacular supernova explosions.

FUSION ENERGY SCIENCES (FES)

The FES program supports research to expand the fundamental understanding of matter at very high temperatures and densities and to build the scientific foundation needed to develop a fusion energy source. This is accomplished through the study of plasma, the fourth state of matter, and how it interacts with its surroundings. Activities include experimental facilities of various scales; international partnerships that leverage U.S. expertise; large-scale numerical simulations based on experimentally validated theoretical models; the development of advanced fusion-relevant materials; and the development of new measurement techniques. The knowledge gained through these activities helps to support the international fusion facility, ITER, which will be the world's first magnetic-confinement burning plasma experiment.

FES supports two scientific user facilities: The National Spherical Torus Experiment (NSTX) at Princeton Plasma Physics Laboratory and DIII-D National Fusion Facility (DIII-D) at General Atomics in San Diego, California.

Currently undergoing an upgrade, NSTX is one of two major facilities in the world exploring the physics of plasmas confined in a spherical torus (ST) configuration. The ST configuration, with its very strong magnetic curvature, can confine plasmas with a pressure that is higher than a conventional tokamak. Research on the ST configuration could lead to the development of smaller, more economical future fusion research facilities. In addition, with its high heating power and compact geometry, NSTX, when upgraded, will have unique capabilities among existing tokamaks to explore new solutions to the plasma-material interface.

DIII-D is the largest magnetic fusion research experiment in the U.S., with a program mission to establish the scientific basis for the optimization of the tokamak approach to fusion energy production. Research focuses on the development of the advanced tokamak concept using active control techniques to manipulate and optimize the plasma to obtain conditions scalable to robust operating points and high fusion gain for ITER and future fusion reactors. A key feature of the DIII-D physics program is the development and use of a large suite of diagnostic measurement capabilities.

ITER, currently under construction as an international project in France, is designed to generate the first sustained burning plasma (300 seconds, self-heated). The ITER Project is an international consortium consisting of the U.S., China, India, Japan, South Korea, the Russian Federation, and the European Union (the host). The U.S. Contributions to the ITER Project is 9.09% of the ITER Project construction costs. The U.S. contributions consist of in-kind hardware components, personnel, and cash to the ITER Organization (IO) for the ITER construction phase. Over 80% of the funding for U.S. contributions to the ITER Project will be spent on in-kind hardware sourced from U.S. industries, national laboratories, and universities. Though progress has been made in the design and early construction at the ITER site, particularly in site preparation; the delivery of support and office buildings; and the foundation of the

tokamak building, the overall progress has been slower than anticipated. We have two reviews to help us assess the path forward the DOE/SC Office of Project Assessment review which will be submitted in October, and the biennial 2013 Management Assessment of ITER that will be released in November.

SCIENCE LABORATORIES INFRASTRUCTURE (SLI)

The Science Laboratories Infrastructure (SLI) program makes important investments in improving the safety, efficiency, and mission readiness of laboratory infrastructure in order to support the scientific mission of the laboratories. Through SLI, SC is ensuring that its laboratories have state-of-the-art facilities and utilities that are flexible, reliable, and sustainable. SLI projects include new and renovated buildings with modern research and support space, as well as important infrastructure improvements that are needed to maintain the lab's ability to support world-leading science.

The SLI program has invested in projects that have the potential for the greatest impact to the scientific mission of the laboratories. For example, construction of the Research Support Building at SLAC National Accelerator Laboratory, completed in May of 2013, allowed for the removal of more than a dozen 35-year old, expensive-to-maintain, trailers. In their place, the new Research Support Building achieved LEED® Gold Certification, the second highest rating for high-performance green buildings offered by the United States Green Buildings Council.

In another example, the renovations and building replacement conducted as part of the Seismic Life-Safety, Modernization, and Replacement of General Purpose Buildings Phase II project at Lawrence Berkeley National Laboratory (2012) addressed significant safety concerns related to potential earthquakes, while providing a modernized home for the laboratory's Earth Science Division.

Other projects, including construction of the Physical Sciences Facility at Pacific Northwest National Laboratory (2011), the Chemical and Materials Sciences Building at Oak Ridge National Laboratory (2011), the Technology and Engineering Development Facility at Thomas Jefferson National Accelerator Facility (2012), and the Interdisciplinary Science Building at Brookhaven National Laboratory (2013), have added state-of-the-art, multidisciplinary research space at each of these institutions.

CONCLUSION

Chairman Lummis, Ranking Member Swalwell, thank you again for the opportunity to testify before the Energy Subcommittee to discuss Office of Science activities and programs as well as challenges and opportunities facing the Department's basic research mission. I would be happy to take any questions you have.

Dr. Patricia M. Dehmer

Acting Director, Office of Science
U.S. Department of Energy

Patricia M. Dehmer has been the Acting Director for the Office of Science since April 2013. She is the Deputy Director for Science Programs in the Office of Science at the U.S. Department of Energy (DOE). In this capacity, Dr. Dehmer is the senior career science official in the Office of Science, which is third largest Federal sponsor of basic research in the United States, the primary supporter of the physical sciences in the U.S., and one of the premier science organizations in the world.

As Deputy Director for Science Programs, Dr. Dehmer provides scientific and management oversight for the six science programs of the Office of Science (basic energy sciences, biological and environmental research, fusion energy sciences, advanced scientific computing research, high energy physics, and nuclear physics), for workforce development for teachers and scientists, and for construction project assessment. The Office of Science supports research at 300 colleges and universities nationwide, at DOE laboratories, and at other private institutions.

From 1995 to 2007, Dr. Dehmer served as the Director of the Office of Basic Energy Sciences (BES) in the Office of Science. Under her leadership, the BES budget more than doubled in size to $1.2B annually. She built a world-leading portfolio of work in condensed matter and materials physics, chemistry, and biosciences. A five-year effort to relate fundamental research in these disciplines to real-world problems in energy – including problems in fossil energy and carbon dioxide sequestration, nuclear energy, renewable energy, energy efficiency, energy transmission and storage, and the mitigation of environmental impacts of energy use – facilitated greater integration of basic and applied research across DOE.

During this period, Dr. Dehmer also was responsible for the planning, design, and construction phases of more than a dozen major construction projects totaling $3 billion. Notable among these were the $1.4 B Spallation Neutron Source at Oak Ridge National Laboratory, five Nanoscale Science Research Centers totaling more than $300M, the total reconstruction of the Stanford Synchrotron Radiation Lightsource at the SLAC National Accelerator Laboratory (SLAC), and the start of two new facilities for x-ray scattering – the Linac Coherent Light Source at SLAC, which is the world's first hard x-ray free electron laser, and the National Synchrotron Light Source II at Brookhaven National Laboratory, which will provide the highest spatial resolution of any synchrotron light source in the world.

Dr. Dehmer began her scientific career as a postdoctoral fellow at Argonne National Laboratory in 1972. She joined the staff of the Laboratory as an Assistant Scientist in 1975 and became a Senior Scientist in 1985. In 1992, the Laboratory established a new scientific rank that recognizes sustained outstanding scientific and engineering research, and Dr. Dehmer was among the 1% of the Laboratory's technical staff promoted to that rank, now called Argonne Distinguished Fellow, in that first year.

Dr. Dehmer's research in atomic, molecular, optical, and chemical physics resulted in more than 125 peer-reviewed scientific articles. Her studies of the interactions of electronic and atomic motion in molecules provided fundamental understanding of energy transfer, molecular rearrangement, and chemical reactivity.

Dr. Dehmer is a fellow of the American Physical Society and the American Association for the Advancement of Science. For the 15 years prior to assuming her position as Director of BES, she served in dozens of elected and appointed positions in scientific and professional societies and on review boards. Dr. Dehmer was awarded the Meritorious Presidential Rank Award in 2000 and 2008 and the Distinguished Presidential Rank Award in 2003.

Dr. Dehmer received the Bachelor of Science degree in Chemistry from the University of Illinois in 1967 and the Ph.D. degree in Chemical Physics from the University of Chicago in 1972.

Chairwoman LUMMIS. Thank you, Dr. Dehmer. My daughter, she is in her 20s. She is obsessed with lists, and I can't wait to call her and tell her there is a list of the top 500 machines, and she will undoubtedly be checking it out before the end of the day. Thanks for your testimony.

I now recognize Dr. Simon to present his testimony.

TESTIMONY OF DR. HORST SIMON, DEPUTY DIRECTOR, LAWRENCE BERKELEY NATIONAL LAB

Dr. SIMON. Chairwoman Lummis, Ranking Member Swalwell and distinguished Members of the Subcommittee, thank you for holding this important hearing and for inviting me to participate. I would like to deviate from my script very slightly and mention that I am a coauthor of the Top500 list, so if there are specific questions on ranking supercomputers, I would be very happy to answer these questions.

As I was introduced, my name is Horst Simon. I am the Deputy Director of Lawrence Berkeley National Laboratory, a multi-program Department of Energy Office of Science laboratory managed by the University of California. Berkeley Lab has a very long and distinguished history of producing world-leading science, and today continues to be an international leader in many scientific fields and technology areas from the mysteries of the universe to delivering new energy solutions.

Considering the challenges that our Nation is facing, there are few issues that are as critical to the Nation's well-being as the vitality and productiveness of our innovation ecosystem. We do have a national ecosystem and it is comprised of universities, the national labs and, of course, industry, and it is the interplay of these three components that make us so competitive and make us very unique. In my daily work, I encounter almost every week visitors from around the world from Asia, from Europe, who come and visit the national labs and want to find out how does a national lab work, how do we interact with industry, how do we interact with universities because that system is very difficult to build and difficult to replicate. All three pieces of the system—universities, industry and national labs—are equally important and need to be supported.

In my comments I would like to focus on what the national labs do. There are three important contributions that the national labs make. One, as has been mentioned by my colleague, Dr. Dehmer, we operate large-scale scientific facilities. These are facilities that are unique, very large, very difficult to build, difficult to maintain and operate, and that require consistent support over many years. These facilities are unique, not just in the Nation but worldwide. They provide a tool for our scientists to engage in really innovative new basic science and advance our state of knowledge.

The second element is large-scale, multidisciplinary team science. Many of the challenges that we are facing today require the approaches that combine the input from very different disciplines. One example, which was mentioned, are the Bio Energy Research Centers. For example, the JBEI Research Center in Berkeley involves scientists that have backgrounds in agriculture, that have backgrounds in chemical engineering, that have backgrounds in bi-

ology. They work on a very challenging problem that will take many years to resolve, that is, getting from cellulosic matter to biofuels. Bringing all of them together and solving of these large, challenging projects is a characteristic of the national labs.

Third, I would like to point out that the national labs have a very important element of education to do. We are supporting, for example, in Berkeley close to 900 postdocs and graduate students. These are individuals who come through the national lab on an ongoing basis. We actually have each year on the order of several hundred students that spend some time at the lab. The labs have an important element for training and educating these students because they learn what the real problems are that the Nation is facing and how the tools of science can be brought to bear on solving these problems. Even if they don't stay in the national lab system, they move on and become either academicians or work in industry and contribute to our innovative national ecosystem. So all three elements are equally important.

I would like to conclude my testimony with a very personal comment. I came to the United States in the 1970s as a graduate student from Germany, and I received my Ph.D. in 1982 in Berkeley. I had not planned to really stay here but being a graduate student in one of the top universities, I found out very quickly that for a scientific career, the United States is the best place to be. I had spent some time in universities and industry and then came back to the national labs in 1995 and had a very, very productive career. I became a citizen a long time ago and very much enjoyed the support that you are providing to scientists like me that advanced my career and I have hopefully contributed significantly to the American innovation ecosystem.

The unfortunate statement that I have to make at the end of my testimony is that if I were to meet myself today, a graduate student getting a Ph.D. in 2013, I am not sure if I could tell him or her the same thing that was true 30 years ago. It is not clear to me that this country has all the tools in place to provide an environment to be a productive environment for scientific inquiry. Thank you.

[The prepared statement of Dr. Simon follows:]

United States House of Representatives
Committee on Science, Space and Technology,
Subcommittee on Energy

Wednesday, October 30, 2013

Providing the Tools for Scientific Discovery and Basic Energy Research: The Department of Energy's Science Mission

Testimony of Dr. Horst Simon
Deputy Laboratory Director
Lawrence Berkeley National Laboratory

Chairwoman Lummis, Ranking Member Swalwell and distinguished members of the subcommittee, thank you for holding this important hearing and for inviting me to participate as a witness.

My name is Horst Simon and I am the Deputy Director of the Lawrence Berkeley National Laboratory (Berkeley Lab), a Department of Energy (DOE) Office of Science multipurpose laboratory managed by the University of California. My scientific area of expertise is High Performance Computing, a field in which I have worked for over 30 years. Before becoming Deputy Director I served as the Director for the National Energy Research Scientific Computing Center (NERSC) and as the Associate Laboratory Director for Computing Sciences at Berkeley Lab. I am one of the editors of the Top500 List of the world's most powerful supercomputers.

Berkeley Lab is the oldest laboratory in the DOE Office of Science complex, tracing its founding by Ernest Orlando Lawrence to 1931. The Lab is a center of world-leading research in many fields, including astrophysics, biology for energy solutions, high performance computing and materials science. Operating five national scientific user facilities, including the world's most powerful electron microscope, the Lab is host to around 10,000 scientists and students that visit the Lab annually to conduct their research.

The Lab enjoys a tremendous symbiotic relationship with the University of California, Berkeley – close to 300 of our researchers have joint appointments as professors on campus. The relationship with the University of California and with local industry creates unparalleled education and training opportunities for students at all stages of their studies. Hundreds of undergrad, graduate and doctoral students are at the Lab everyday preparing for their future research careers. We are also fortunate to draw upon the intellectual and technological capital of the San Francisco Bay Area to advance our mission.

Considering the economic and national security challenges facing our nation, there are few issues as critical to the nation's wellbeing as the vitality and productiveness of our innovation ecosystem. I am honored to be here today as a part of this distinguished panel and am delighted to offer my views on a very important aspect of that ecosystem – the Department of Energy Office of Science and its national laboratories.

My comments are divided primarily into two categories.

1. I will attempt to describe for the Committee what national laboratories are, why they are important and how they serve a fundamental and foundational role in the nation's innovation ecosystem. Although I work at Berkeley Lab, I will utilize examples and describe issues from throughout the Office of Science laboratory complex.

2. I will comment on the draft bill that the committee is considering. Many of these comments are based on discussions I have had over many months with my colleagues at Berkeley Lab and at other labs. Some of my comments are, however, based on my own professional experience and are my opinions solely – not the views of Berkeley Lab or the Department of Energy.

What are the Office of Science national laboratories and why are they important to the nation's economic and national security?

The course of humanity often runs along well-worn ruts uninterrupted except when redirected by extraordinary events or by extraordinary individuals facing extraordinary challenges. Such was the case during the first third of the 20th century in the United States, when a core group of outstanding scientists and their colleagues in non-scientific fields, working on the frontiers of physics, unknowingly laid the scientific and infrastructure foundation for the modern national laboratory. With an entrepreneurial, team-science approach, scientific leaders like Ernest Orlando Lawrence, Enrico Fermi, and Alfred Loomis begged, borrowed and otherwise found the resources to establish a new type of research enterprise – one no longer dependent on the single principal investigator and a small team of post doctoral and graduate students. Rather, they crafted large, multidisciplinary teams whose members pulled together in lockstep toward common scientific goals.

For Lawrence, a young professor at the University of California, his singular focus was on developing and perfecting the cyclotron, a particle accelerator with great potential for deciphering the riddles of physics and for unveiling secrets to a host of scientific mysteries. To build the cyclotron and to capture it's scientific potential, Lawrence brought together a diverse and capable team of scientists, engineers, machinists, accountants, administrative staff, students, post docs and other disciplines that did not normally mix at such a scale. It was a productive undertaking that led to remarkable results – results that won the Nobel Prize, captured the imagination of the general public and caught the attention of officials in Washington.

With the advent of World War II and the pressing need to establish technological supremacy in the fight against fascism, the federal government, armed with unprecedented funding for science and technology development, turned to the giants of research for their help. From Lawrence's Berkeley "Rad Lab" and Loomis' laboratory of the same name at M.I.T., to Fermi's nuclear physics lab at the University of Chicago, the federal government enlisted the help of the best and brightest to meet the challenges of war. The Manhattan Project was stood up and the rest, as they say, "is history." In the process, and unwittingly, the mold of the national laboratory was set.

The mold was big team science using big scientific tools to tackle big societal problems. Although the times have changed, and although the challenges and opportunities facing our nation are not the same as they were in 1939, the

fundamental role of our national laboratories in the U.S.'s innovation ecosystem is as important, or more important, today as back then.

Today, the legacy of these scientific superstars, the federal government's initial and ongoing investment, and the public service of thousands of dedicated scientists, engineers, managers, administrators and others is a network of national laboratories that is unmatched and envied by the rest of the world. The Office of Science oversees ten national laboratories – each with a unique set of expertise, resources, facilities and users – each providing world-class scientific capabilities to a diverse set of researchers from around the nation and the world. From unraveling the mysteries of the universe – space, time, mass and energy – and leading the world in the development of high performance computing, to creating new materials and biological processes that advance transformational energy solutions and aid in environmental cleanup, the national laboratories and the Office of Science are an irreplaceable part of the nation's innovation ecosystem.

Keeping with the management structure set in place during the Manhattan Project, the labs are still operated by universities, private sector companies and other organizations on behalf of the Department of Energy. Dubbed management and operating contractors (or M&O contractors), entities such as the University of California, Battelle Memorial Institute, Stanford University and others provide DOE with access to researchers who are often at the top of their fields, students training to become the next generation's scientists, and the intellectual freedom to push the boundaries of knowledge and pave the way for transformational discoveries. The M&O contracting model has been extremely effective and efficient – leading to extraordinary scientific accomplishments at the national laboratories. At Berkeley Lab, for instance, the close proximity of a world leading research lab to a world leading research university has led to a remarkable symbiosis of academic entrepreneurialism and societal-scale mission objectives. Like Lawrence's early achievements, the results continue to be remarkable – 13 Nobel Prizes and a current roster of researchers that makes up about 3 percent of the National Academy of Sciences, and research that is consistently recognized as world class across many disciplines.

Build and operate national scientific user facilities

From Lawrence's accelerators to Fermi's nuclear research reactors, a central role of the national laboratory has been, and remains, to conceive of, design, build and operate unique scientific tools and machines. DOE's Office of Science, as steward of today's national science laboratories and as the major funder of the physical sciences in the United States, operates thirty-one national scientific user facilities (full list is attached to this testimony). The facilities include light sources that peer into materials at the molecular and atomic scale to determine structure and chemistry, accelerators that collide subatomic particles at speeds approaching the speed of light, some of the world's most powerful supercomputers, facilities that

sequence and reveal secrets of plant and microbial genomes, and the world's most powerful electron microscopes.

These tools, including the Advanced Light Source at Berkeley Lab, the Spallation Neutron Source at Oak Ridge, and the Center for Nanoscale Materials at Argonne National Laboratory provide tens of thousands of American researchers access to critical scientific capabilities that help them to maintain the nation's scientific leadership. These researchers come from both academia and industry; are funded by a host of federal agencies, philanthropic organizations and companies; and come from every state in the union and the District of Columbia. Thus, a substantial amount of the funding provided to the national laboratories for the operation of these facilities is expended in support of research conducted by non-DOE users, mostly from universities. The facilities are made available at no charge to researchers doing nonproprietary work. In other words, their research must be published and made available to the broader scientific community.

The user facilities also provide irreplaceable capabilities and expertise to companies working to develop new products and processes for commercial applications. From semiconductor research to speeding new pharmaceutical solutions to patients, the user facilities have become a critical component in industrial R&D. All sizes of companies, Fortune 500 as well as startups and medium size enterprises, utilize these special scientific tools. For many of them, the user facilities have become an important part of their R&D programs. If companies keep their research private, they pay a fee at an hourly rate for their use of the facility.

A few examples provide a good glimpse of the value of these facilities to the nation.

> <u>GE and the Oak Ridge Leadership Computing Facility</u>
> General Electric (GE) collaborated with Oak Ridge Leadership Computing Facility researchers to utilize the Cray XK7 Titan supercomputer, one of the world's most powerful computers, to conduct very large molecular simulations, not feasible on smaller systems, to better understand why ice forms on various material surfaces, such as the blade of wind turbines. The formation and accumulation of ice on wind turbine blades limits where wind turbines can be deployed safely and effectively, despite the availability of abundant wind.
>
> GE ran hundreds of simulations of million-molecule water droplets on Titan that examined freezing behavior across many different surface and temperature combinations (typical studies can only simulate 1,000 molecule droplets). Results are revealing surface and temperature combinations that hold the most promise for reducing debilitating ice formation. This in turn is helping experimentalists better focus their research so they can reduce the number of time-consuming and costly physical experiments.
>
> <u>Argonne and New Material that Dents Diamonds</u>
> At Argonne National Laboratory's Advanced Photon Source, a remarkable tool for examining materials at the atomic and molecular level, an international team of

scientists created a new super-hard form of carbon. Carbon materials, such as graphene, graphite, buckyballs and nanontubes, display a remarkable range of mechanical, electronic and electrochemical properties that make them sought-after materials for advanced products in electronics and nanotechnology.

Led by scientists with the Carnegie Institute of Washington's Geophysical Laboratory, the research team made up of researchers from Argonne, Jilin University, the University of Nebraska at Lincoln, Stanford University and SLAC National Accelerator Laboratory, created a carbon material that is comparable to diamond in its inability to be compressed. Not only is the new material incredibly strong – it can dent diamond, the hardest substance on Earth – it is also able to retain its new super-hard form even when the high pressure that created it was removed. Researchers and potential industrial users are excited by the new material's ability to maintain its super-hard status without continual pressure – a key requirement for commercial applications.

The World's Most Powerful Electron Microscope and Lighter, Stronger Alloys
Researchers at Berkeley Lab's National Center for Electron Microscopy employed the world's most powerful electron microscope to discover how nanoparticle size can be controlled to make stronger metal alloys. Their findings provided an atomic-scale view into the properties of metal nanoparticles in aluminum, yielding a high-strength, lightweight, potentially heat- and corrosion-resistant alloy for use in airplane engines and other aerospace applications. These new microstructures could lead to the next generation of lightweight aerospace and automotive aluminum alloys.

World leading research for DOE mission objectives

The DOE Office of Science national user facilities are obviously a competitive asset of America's research and innovation enterprise. The robust utilization of these facilities by researchers from throughout the research community – academia, industry and other research institutions – is strong evidence of their value to the nation. They are irreplaceable. What may not be as obvious as the importance of the brick and mortar facilities, but is just as critical to their success and to the success of our nation's innovation enterprise, are the research programs at the national laboratories and at universities funded by the Office of Science.

As I mentioned previously, DOE's Office of Science is the largest funder of the physical sciences in the United States – and, perhaps in the world. The physical sciences include such fields as material sciences, chemistry, physics and geology. Most people believe that the National Science Foundation or other science agencies make up the majority of federal investments in these areas – yet, this is a mistaken belief. Communicating science effectively is always a difficult challenge – we try, but we could do much better. Under Pat Dehmer's leadership, the Office of Science, and the national laboratories, are improving our outreach. We hope that you will help us by reaching out to your colleagues and educating them about the important work of the Office of Science.

As a critical tool in advancing its scientific mission, the Office of Science is also the nation's steward of pushing the frontiers of scientific computing – high performance computing for science and technology. As a practitioner in this field for many years, I have witnessed firsthand the ever-increasing value of computing to science and to addressing the challenges we face as a nation and those that we face as citizens of the world. Computing, through simulation, modeling and data analysis, has become the third leg, along with theory and experimentation, in the three-legged stool of research.

Additionally, the Office of Science is the largest funder of non-human related biological research – such as research into energy solutions and environmental remediation. This is another often well-kept secret.

The physical sciences, computing and biology each helps to advance key DOE and Office of Science mission needs and objectives. All are focused on research and technology development unique to DOE, but applicable to the broader research ecosystem. They make new discoveries possible and lead to a better understanding of the world around us and to solutions to some of our thorniest problems. Additionally, a robust Office of Science research program is necessary to ensure that scientists, engineers and facility operators at the national user facilities remain at the front end of science in their respective fields. In my observations, the value of the user facilities to visiting researchers, whether from NSF, NIH, NASA or elsewhere, is directly correlated to the skill and expertise of the user facility scientific staff. Not investing in the research mission and building the scientific chops of laboratory scientists would be wasting the great federal investment in these national assets.

Solving societal challenges through team science

Attacking problems of scale is a legacy for the national laboratories that was established by Lawrence and his colleagues. As described earlier, the mold was big team science using big scientific tools to tackle big societal problems. Today, one of the most enviable aspects of the national laboratory system remains its ability to organize multidisciplinary teams and bring their intellectual and technological knowhow to bear on complicated research challenges. The national laboratories have a flexibility that doesn't exist at most research universities, and the ability to focus on research that industry would never undertake – at least not today, not since the demise of the great industrial labs of Bell, Xerox and others. Consequently, the labs are fertile ground for forming collaborations and teams to address contemporary challenges in an immediate and fundamental way.

As with the national user facilities, a few good examples illustrate the value of DOE team science.

Joint BioEnergy Institute and High Throughput Spectrometry

Researchers at the Joint BioEnergy Institute (JBEI) at Berkeley Lab, a DOE Office of Science Bioenergy Research Center, have developed an advanced technology to dramatically speed up and lower the cost of developing lignocellulosic biofuels. Led by researchers from JBEI, the effort required a team-based approach from the start. JBEI is a great example of team science as it includes researchers from four national laboratories and three universities, with a dynamic and important industry advisory council. Gathered under one roof, plant physiologists, microbial engineers, computer scientists and others from these institutions work together seamlessly toward JBEI's scientific and technology objectives. Drawing from its diversity and depth of research capabilities this group tackled this project in a very Lawrence-inspired team science mode.

Their success was a new high-speed chemical screening system, with the complicated name High Throughput Nanostructure-Initiator Mass Spectrometry (NIMS), that makes novel use of miniaturization, lasers, specialized chemistries and robotics. NIMS can precisely determine the molecular composition of tens of thousands of samples deposited on a single silicon slide. Each tiny sample is shot with a laser and analyzed in a split second. By working at speeds 100 times faster than that of conventional probes NIMS can cost-effectively profile thousands of samples in a split second.

High Throughput NIMS is being used at JBEI to screen for enzymes that can be used to modify lignocellulose for the production of advanced biofuels that could replace gasoline, diesel and jet fuel on a gallon-for-gallon basis. This technology was recognized with an R&D100 Award by *R&D Magazine*.

The Relativistic Heavy Ion Collider and Discovery Science

At Brookhaven National Laboratory, more than 1,000 scientists from around the world collaborate on research at the Relativistic Heavy Ion Collider (RHIC). At RHIC, thousands of light-speed particle collisions take place each second, recreating the extraordinary conditions of the early universe, as detectors track the subatomic debris to gain clues about the building blocks of matter. When RHIC started operations in June 2000, physicists expected they'd see telltale signatures of elementary particles behaving like a gas. Instead there were many unexpected findings. Working in smaller groups to analyze pieces of data from two large experiments, RHIC physicists concluded that what they were seeing was a liquid. And not just any liquid, but the most perfect liquid ever created, flowing with virtually no resistance. This stunning surprise has opened up a large number of new questions that scientists are now working to answer.

This research—too large, complex, and costly to be conducted by any individual institution—is a classic example of "big team" science. Investments of time, expertise, and money from across the globe divide the challenge of addressing

complicated questions of physics into manageable chunks. Likewise, collaboration members—often working from their home institutions—sift through subsets of RHIC data to explore small pieces of the bigger puzzle, sharing insights, discussing implications, preparing publications, and exploring new questions via email and at meetings.

Development of Advanced Materials Gets Boost from Supercomputers

In a new, technology-enabled form of team science, the Materials Project – an open-access database developed by Berkeley Lab and MIT for materials research – is working with the medium sized company Intermolecular, Inc. to enhance modeling capabilities and accelerate the speed of new material development by tenfold or more over conventional approaches. New materials are key to addressing challenges in energy, healthcare and national security.

Located at the National Energy Research Scientific Computing Center (NERSC), the Materials Project was designed to be an open and accessible tool for scientists and engineers working in both the public and private sectors and now has more than 4,000 users who can explore the properties of 35,000 different materials. This helps scientists avoid the typical trial and error and educated guesses with a systematic approach to designing materials for better batteries, solar cells, electric vehicles, hydrogen storage, catalyst design, and fuel cells.

Using conventional approaches, it takes about 18 years to conceptualize and commercialize a new material. The Materials Project is meant to address this bottleneck by using a genomics approach to materials science – it uses NERSC's supercomputers to characterize the properties of all known materials and thus takes some of the guesswork out of materials design. Intermolecular, based in San Jose, California, will provide data from its proprietary high-throughput combinatorial experimentation and characterization toolset to the Materials Project to enable it to develop better predictive materials models.

National Laboratories are just one part of our national innovation ecosystem

As intimated previously, the DOE Office of Science and its national laboratories are just one part, although a fundamental part, of the nation's innovation ecosystem. American innovation is underpinned by people, ideas and tools – it is this organic system that is envied by and unmatched in the world. The core components of this innovation ecosystem are universities, national laboratories and industry. Like the national laboratory complex, this ecosystem grew out of a World War II and post-World War II commitment made by the federal government to support scientific research.

In today's highly competitive global environment, the U.S. innovation ecosystem is one of our nation's most precious assets. The federal government has a fundamental responsibility to keep this ecosystem healthy, because it gives the

nation a powerful competitive edge, providing solutions to major national challenges and fueling economic growth. At the same time, universities and laboratories have a fundamental responsibility to be sensible stewards of taxpayer funds, conduct first-rate research on key scientific and technological problems with intellectual rigor and efficient use of resources, and strive to transfer the results of this research to markets for the benefit of society as a whole.

The particular roles of the national laboratories in the nation's innovation ecosystem have been examined previously; to recap, they are:

- Build and maintain unique, large-scale and world-leading research tools that are utilized broadly by university and industrial researchers
- Assemble and nurture multi-disciplinary teams of scientific experts to meet federal needs and address national priorities by attacking R&D challenges of scale
- Serve as an irreplaceable on-the-job training ground for undergraduate, graduate and post-doctoral students, faculty, and early career scientists

Important as these roles are to the foundation that underpins the U.S.'s innovation ecosystem, they are only as vital and as strong as the other parts of the foundation.

Universities educate and train the scientists, engineers and teachers that make up the ranks of researchers and technology developers across the national laboratory complex and within industry. Professors and their students drive the generation of new ideas by performing cutting-edge research in an academic environment that rewards creative thinking and discovery science. Universities also play a critical role in weaving key issues of policy and society into research and development.

Industry delivers technological advances to the marketplace and to society by making strategic, early investments in new technology. With an employee base of scientific and engineering talent produced by universities and trained at national laboratories, industry drives commerce and innovation that helps businesses remain globally competitive. This talent gives companies the in-house research capabilities to harness the scientific advances and technology developed at universities and at national laboratories – including the utilization of the unique research tools of the national laboratories – to move technologies to the marketplace.

The federal commitment to each of these areas – through the DOE Office of Science for national laboratories, the NSF, NIH, NIST, NASA and others for universities and industry, and research incentives, public-private partnerships, and technology transfer for industry – is equally necessary to making the ecosystem healthy and vital. So, the next time you think about, or speak about, the federal support for science, I hope that you will consider the entire universe of what it takes to make the U.S. research enterprise successful.

Comments on the proposed EINSTEIN America Act

Finally, I will turn this testimony's attention to the draft EINSTEIN America Act, legislation that would reauthorize the DOE Office of Science. First, let me applaud the Members and staff of the Subcommittee, and of the full Committee, for your foresight and wisdom in taking up this legislation and thereby signaling your support for the Office of Science and the great work that it does. Although the Office of Science operates some of the most famous and most distinguished laboratories in the world and has demonstrated its ability to deliver great science and technological advancement for the nation time and time again, it often does not get the recognition it deserves. It needs and deserves the full attention of the Congress. Thank you for this recognition.

As I mentioned at the beginning of this testimony, my comments about the legislation are derived from a combination of discussions with colleagues at Berkeley Lab and elsewhere, and my own bias. That said, my views today are my own and do not represent the views of Berkeley Lab or of the DOE. I still hope that you find them useful. For ease of following, the comments below are divided into the sections and subsections of the draft provisions on which I am commenting – I will not address every section of the bill.

Section 102. Basic Energy Sciences (BES)

My testimony earlier described the irreplaceable symbiotic relationship between the Office of Science's national scientific user facilities and its research program. As with the Office of Science, much of the magic of BES's success stems from the careful balance of resources between its facilities and its research program. The BES provisions of the EINSTEIN America Act could perhaps more directly address and support this reality and thereby more clearly reflect the balance between these areas. Research programs within BES that this Committee has endorsed in the past, with strong bipartisan support, such as the Energy Frontier Research Centers and the Energy Innovation Hubs, have shown great results and offer continuing progress. These programs have harnessed, at labs and at universities, multidisciplinary approaches to addressing tough fundamental science questions. I believe that the bill would benefit and be a stronger document with more attention paid to the research portfolio of BES.

Section 103. Advanced Scientific Computing Research (ASCR)

Advanced scientific computing is the third leg in the three-legged stool of modern research. I made this point earlier in the testimony. Computing applications in modeling and simulation are becoming breathtaking in their capabilities and utilization. Likewise, the amount of and complexity of data for computation research are skyrocketing. At NERSC, which is utilized by around 5,000 users from across the nation, we've seen an explosion in the size and complexity of data sets and the creative applications of the researchers. The Materials Project that I mentioned earlier is a great example of the power of data to advance science. Not only are high performance computers needed to store and analyze data, they make possible new methods of conducting team science in exciting ways. As a nation we must meet head-on the opportunities for scientific

advancement that computing makes possible. We cannot afford to lag behind other countries in the development of our computational resources. Computing speeds up the pace of research and of applying research to the real world. It speeds up commercial development of technologies and provides a critical competitive advantage. The U.S. no longer has the research and technology lead we once enjoyed. We must invest in new computational technologies and we must do so now – hopefully staying ahead of the curve instead of falling behind it. I applaud the Committee for its attention to the matter and to Congressman Hultgren and the cosponsors of his legislation, including our Congresswoman, Barbara Lee, Congresswoman Lofgren and Ranking Member Swalwell. Thank you for your support of this important initiative.

Section 104. High Energy Physics (HEP)

For starters, I recognize that high energy physics is hard to understand – I am not a physicist and will gladly admit that the often esoteric nature of physics research is beyond an easy grasp. That said, discovery science, such as the research funded by DOE's Office of Science High Energy Physics program is the proverbial seed corn for the transformative scientific and technological advancements of the future. Research that leads to incremental changes, changes at the margin, are more easily discussed, digested and understood. Research on the outer edges of our knowledge and understanding of the universe and its constituent parts – energy, mass, space and time – is by its very nature much harder to understand. Yet, without it and without funding it properly, we are at great danger for sacrificing the future of our children, grandchildren and their progeny. I am not just talking about U.S. global competitiveness, although it would suffer immensely, but also about our ability as humans to adapt, improve, succeed and create a better world. Fundamental, discovery science makes possible the seemingly impossible. As for the HEP provisions in the draft legislation, I suggest adding language comparable to the underground research subsections regarding other fields of physics in which the U.S. enjoys international leadership, such as in the cosmic frontier that looks to the universe to unravel the mysteries of our world.

Section 105. Biological and Environmental Research (BER)

Getting the word out about the important role the Office of Science plays in biological research through BER is a big challenge. This is unfortunate because BER funds critical biological research which is not significantly funded by any other federal agency – biological research into energy solutions, environmental remediation and the effects on humans of energy production. There is a broad misunderstanding that all biology-related research is funded through NIH. This is a dangerous misconception that inadvertently ignores whole areas of science that offer great promise to address many of our toughest challenges. Other countries, our global competitors, are focusing a great deal of resources and attention to this area – however, we currently lead the field and should continue to do so. I have no specific comments regarding the legislative draft in this area, but do have a few general observations. First, our capabilities and knowledge in the biological sciences have grown exponentially over the past couple of decades. We are poised to make great advances that will have direct and positive implications for DOE's core mission needs.

Second, researchers now have the capability and expertise to look at whole biological systems – whether they are local, regional or worldwide – from the microscopic to the large. And last, biology is poised to become an extremely data-intensive science. DOE and the Office of Science are well poised to productively harness this phenomenon by bringing together its biological research and supercomputing assets and expertise. As a nation, we should focus on developing the capability to analyze, learn and lead on the science of the microbe to the biome – that is from the microscopic to the large systems level.

Section 109. External Relations

The health and safety of our employees, guests and neighbors is our primary task and we place it above all other issues. That said, systems and processes to ensure and safeguard the health and safety of our lab and local community have become burdensome and have focused too much on reporting and not enough on results. The external regulation of the DOE Office of Science national laboratories is an issue that has been discussed for many years. At places like Berkeley Lab, students and researchers may work part of the day at UC Berkeley and the remainder of the day at Berkeley Lab, yet work under different EH&S regulations at each institution. The same researchers are doing the same type of scientific work, with federal funding – possibly from DOE in both cases – but they are regulated differently on how they perform that work depending upon where they are standing. It is a confusing and needlessly onerous situation. Charles Shank, a former Director of Berkeley Lab, testified before the Congress on this issue in 2002 and reported on the successful results of external regulation pilot studies at Berkeley Lab with the Nuclear Regulatory Commission and with the Occupational Health and Safety Administration. Both pilots led these agencies to conclude that they could safely and effectively manage the oversight of the Lab in their respective areas of responsibility. I would suspect that they would come to the same conclusion today. However, as Director Shank warned the Committee in 2002, and I quote, "would external regulation be layered on top of current DOE orders? We fear a world of overlapping and redundant responsibilities that would make it difficult for us to do our work.... Let me be perfectly clear on this point: a layered, redundant oversight, subjecting the laboratories to regulatory oversight by ... the DOE and NRC and OSHA, would result in a more expensive and confusing ES&H climate." Director Shank's testimony is attached for your review and consideration.

Science Laboratories Infrastructure (SLI)

Science Laboratories Infrastructure is not mentioned in the bill. This is unfortunate, as SLI plays an irreplaceable role in upgrading the facilities and infrastructure of the national laboratories. Without it, labs would not be able to renew their facilities and ensure that employees have access to safe and modern research infrastructure. At Berkeley Lab, for instance, SLI has funded and plans to continue funding

improvements that correct or replace seismically unsafe building stock. I encourage the Members of the Committee and staff to consider adding a section to the legislation that recognizes and authorizes this important function and funding vehicle.

Conclusion

Again, thank you for inviting me to participate in this important hearing. I look forward to your questions. Please never hesitate to let me know how I may be of assistance.

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Horst Simon, an internationally recognized expert in computer science and applied mathematics, was named Berkeley Lab's Deputy Director on September 13, 2010. Simon joined the Lab in early 1996 as director of the newly formed National Energy Research Scientific Computing Center (NERSC), and was one of the key architects in establishing NERSC at its new location in Berkeley. Under his leadership NERSC enabled important discoveries for research in fields ranging from global climate modeling to astrophysics. Simon was also the founding director of Berkeley Lab's Computational Research Division, which conducts applied research and development in computer science, computational science, and applied mathematics.

In his prior role as Associate Lab Director for Computing Sciences, Simon helped to establish Berkeley Lab as a world leader in providing supercomputing resources to support research across a wide spectrum of scientific disciplines. He has also served as an adjunct professor in the College of Engineering at the University of California, Berkeley, working to bring the Lab and the campus closer together and developing a designated graduate emphasis in computational science and engineering. In addition, he has worked with project managers from the Department of Energy, the National Institutes of Health, the Department of Defense and other agencies, helping researchers define their project requirements and solve technical challenges.

Simon's research interests are in the development of sparse matrix algorithms, algorithms for large-scale eigenvalue problems, and domain decomposition algorithms for unstructured domains for parallel processing. His algorithm research efforts were honored with the 1988 and the 2009 Gordon Bell Prize for parallel processing research. He was also member of the NASA team that developed the NAS Parallel Benchmarks, a widely used standard for evaluating the performance of massively parallel systems. He is co-editor of the biannual TOP500 list that tracks the most powerful supercomputers worldwide, as well as related architecture and technology trends.

He holds an undergraduate degree in mathematics from the Technische Universtät, in Berlin, Germany, and a Ph.D. in Mathematics from the University of California at Berkeley.

For more information about Horst Simon, visit his Website at http://www.lbl.gov/Publications/Deputy-Director/bio.html.

Chairwoman LUMMIS. Dr. Simon, thank you for your statement. I now recognize Dr. Hemminger to present his testimony.

TESTIMONY OF DR. JOHN HEMMINGER, CHAIRMAN, BASIC ENERGY SCIENCES ADVISORY COMMITTEE, DEPARTMENT OF ENERGY

Dr. HEMMINGER. Thank you, Chair Lummis, Ranking Member Swalwell and Members of the Energy Subcommittee. My name is John Hemminger. I am Professor of Chemistry and Vice Chancellor for Research at the University of California at Irvine. I also serve as Chair of BESAC, the Basic Energy Sciences Advisory Committee, of the Office of Science. I appreciate the opportunity to appear before you today to provide my insight into the Office of Science and the Office of Basic Energy Sciences of DOE and to provide information on the activities of the Basic Energy Sciences Advisory Committee.

In 2005, the U.S. National Academy sounded an alarm about the erosion of our global scientific and technological leadership with the publication of the report "Rising Above the Gathering Storm." I think it is fair to say that a majority of somewhat complacent U.S. public and science infrastructure was stunned by this report. The response was swift and aggressive as this committee and the Congress passed the *America COMPETES Act* of 2007, which was then reauthorized in 2010. Last month, the chancellors and presidents of over 200 U.S. universities sent an open letter to Congress and the President expressing their serious concerns about what they referred to as the increasing U.S. innovation deficit. Their call to action was echoed in a similar letter from over a dozen associations representing the U.S. high-technology business community.

The origin of the U.S. innovation deficit is clear. It is a direct result of our success. Since World War II, the U.S. Federal Government has invested heavily in all areas of fundamental science and technology. The result is the technologically sophisticated society we have today. Our success has not been lost on our global competition, especially countries in Asia and the European Union are investing heavily in fundamental science and technology. We have taught them by example. The growing innovation deficit is nowhere more critical than in energy science and technology where the United States is being challenged by increasingly sophisticated competitors. In my written testimony, I provided a concrete example, pointing out that the longstanding U.S. global leadership in large-science user facilities such as those managed by the Office of Basic Energy Sciences is being challenged as a result of major investments by countries in Europe.

In my testimony, I described how the Basic Energy Sciences Advisory Committee provides advice to the Office of Science and the Office of Basic Energy Sciences. I have provided the Committee with copies of reports that have resulted from three recent studies. Each report has specific findings and makes specific recommendations. I would like to take this opportunity to applaud the leadership of the Office of Science and the Office of Basic Energy Sciences for acting rapidly and effectively to implement the recommendations that resulted from these studies.

Since I was asked in my invitation letter to do so, I would like to conclude with a few remarks regarding the draft language for the EINSTEIN Act. I did provide a few observations in my written testimony. I would like to make two additional observations at this time.

First, there are several examples in the draft legislation where specific areas of science are called out for attention, prioritizing them above other activities, and yet other important areas are not mentioned. One example is in the language associated with the Office of Biological and Environmental Research, which is given a broad charge "to carry out a program of research, development and demonstration in areas of biological system science and climate and environmental science." Yet only biological systems and genomic science and low-does radiation research are addressed in detail in the draft legislation. Based on my own expertise, I would suggest that areas such as the development of a complete molecular-level understanding of the chemistry that underlies environmental pollution such as smog production and climate change should receive an equal emphasis from this office, given the importance to energy technology in the United States.

I would also like to reiterate my concerns about the U.S. innovation deficit. I am concerned that the slight increase in funding associated with the draft legislative language I was provided will not be sufficient to allow the United States to recapture our leadership role in many areas of energy science. Let me assure you that I and my colleagues in the U.S. science community recognize the complex and serious budget issues facing our country. However, I am convinced that strategic investments in fundamental science research and education will be part of the solution, not of the problem.

I want to thank you once again for your leadership and historical support of U.S. science and technology and also for the opportunity to be here today. Thank you very much.

[The prepared statement of Dr. Hemminger follows:]

JOHN C. HEMMINGER

Vice Chancellor for Research
Professor of Chemistry
University of California, Irvine

Chair, Basic Energy Sciences Advisory Committee
Office of Science, US Department of Energy

October 30, 2013

Testimony prepared for the hearing of
The Subcommittee on Energy of the Committee on Science, Space, and Technology

Providing the Tools for Scientific Discovery and Basic Energy Research: The Department of Energy Science Mission

Chair, Cynthia Lummis, Ranking member Eric Swalwell, members of the Energy Subcommittee, my name is John C. Hemminger, I am a Professor of Chemistry and Vice Chancellor for Research at the University of California, Irvine, and I serve as Chair of the Basic Energy Sciences Advisory Committee (BESAC) of the DOE Office of Science. I appreciate the opportunity to appear before you today to provide my insight into the Office of Science and the Office of Basic Energy Sciences of DOE, and information on the activities of the Basic Energy Sciences Advisory Committee of the Office of Science of DOE.

Last month, in an effort led by the Association of American Universities and the Association of Public Land-Grant Universities, the Presidents and Chancellors of over 200 U.S. universities sent an open letter to President Obama and the 113th Congress expressing their concerns about the increasing **innovation deficit** experienced by the U.S. The innovation deficit is the result of cuts to the federal investments in research and higher education at a time when other nations, having learned from the unprecedented success of U.S. technological innovation since World War II, have dramatically increased their investments in research and higher education. In addition, the leaders of over a dozen associations representing the U.S. high technology business community sent a letter echoing these concerns and asking the President, and Congress for their leadership in closing the innovation deficit. The innovation deficit is particularly troubling in the area of energy science and technology. It is abundantly clear that increased investments in research and education are required for the U.S. to obtain and continue to have energy independence. A specific example of the growing innovation deficit involves the U.S.

global leadership of light source user facilities, which I will address in more detail later in my testimony. The strong support from Congress and the American people for fundamental scientific research and higher education has been responsible for the technological innovation that resulted in the position of leadership that we enjoy in the world today. It is essential that these strategic investments continue at a level that will allow us to remain competitive on the world stage.

You have asked me to address three important topics:

• 1. Summarize the work of the Basic Energy Sciences Advisory Committee (BESAC) in reviewing DOE's Basic Energy Sciences (BES) program. Specifically, please discuss significant challenges and opportunities facing BES, as well as key findings and recommendations from recent BESAC reports.

• 2. Discuss the role of DOE national laboratories and national scientific user facilities in the broader American scientific research enterprise. Please provide recommendations to improve coordination between DOE laboratories and user facilities with national lab, academic, and industry stakeholders.

• 3. Comment on the attached draft legislative language and provide recommendations on how the Office of Science can help the United States maintain global leadership in fundamental science activities in a constrained budget environment.

1. BESAC Activities

The BESAC membership includes a diverse group of internationally recognized scientists and engineers from academic institutions, national laboratories, and industry. For the subcommittee's information, the present membership of BESAC is listed in an appendix to this testimony. I am honored to be Chair of this group. Each year BESAC assembles a Committee of Visitors (COV) to review the management practices of one of the three divisions of BES (on a rotating basis). The COV reports (vetted and approved by the full BESAC committee during a public meeting) provide critical advise to the leadership of BES and the Office of Science. I am extremely pleased to be able to say that the BES and Office of Science leadership take the COV activities seriously and historically have acted swiftly and effectively on recommendations that emerge from the reports.

In addition, BESAC acts on Charges received from the Director of the Office of Science to carry out studies on particular topics and provide advice on critical science, technology, and organization issues related to the mission of BES. These studies typically result in major reports that are broadly disseminated. Among recent BESAC reports are the following three that I will comment on briefly in this testimony:

"Directing Matter and Energy: Five Challenges for Science and the Imagination" (referred to herein as the "Grand Challenges Report")

"From Quanta to the Continuum: Opportunities for Mesoscale Science" (referred to herein as the "Mesoscale Science Report")

and "Future U.S. X-ray Light Source Facilities" (referred to herein as the Future Light Sources Report).

I have provided copies of these three reports to the committee today.

Grand Challenges Report

In the context of the BESAC grand challenge study a "Grand Challenge" is an area or topic in science for which, to put it simply, *"we do not know how nature works"*, **and** it is reasonable to expect that developing an understanding of *how nature works* will take a concerted—often multidisciplinary--effort over an extended time period, **and** importantly the solution of this challenge has the potential to lead to a significant, breakthrough impact on Energy Science. The grand challenge study led to the elucidation of five important grand challenge science issues, which are developed in detail in the BESAC report. The *Grand Challenges Report* was issued in 2007. A recent BESAC activity reaffirmed the importance and timeliness of these specific grand challenges. The *Grand Challenges Report* also provided a number of specific recommendations for consideration by the BES and Office of Science leadership. Among these recommendations were: (1) the extreme importance of the development of the Energy Sciences Workforce, and suggestions for potential programs to accomplish this, (2) attention needs to be paid to critical areas of Energy science and technology where the U.S. is in danger of losing or has forfeited its world leadership (e.g., detector science for x-ray light source and other facilities, and high quality crystal growth technologies), and (3) the development of *"team science"* approaches to addressing challenging energy science problems. I will

comment in more detail in a later section on the energy science workforce issues. BES is developing programs to address critical science/technology issues identified in the report. The *"team science"* concept has been addressed in an extremely successful manner with the launch of the **Energy Frontier Research Center** (EFRC) program within BES. In 2009, BES launched 46 EFRCs, with the charge to *"couple grand challenge science with research needs from any of the BES energy needs workshops*". Each EFRC was funded for five years at a funding level sufficient to support multiple investigators to enable significant scope and complexity. Initiating such a new research support mechanism (multiple investigators, at multiple institutions (both academic and national lab) is a tremendous challenge. While the *Grand Challenges Report* indicated that it was appropriate to develop "team science" as one **component** of the BES research portfolio the outstanding success of the EFRC program is a great credit to the BES leadership, and the broad BES energy science community. A funding opportunity announcement has recently been issued for re-competition of the EFRC program.

Mesoscale Science Report

With the launch of the National Nanotechnology Initiative (NNI) in 2000 the United States introduced the world to the importance of nanotechnology. The concerted activity in the arena of nanoscience and technology by a number of U.S. R&D departments and agencies has maintained our world leadership in a variety of important areas of science and technology. As a result over the last 15-20 years we have learned much about the unique and important properties of atoms and

molecules and nanoscale sized structures. It is, however, also very clear that many of the functional properties that we care about for materials we use on an everyday basis a larger more complex length scale—the meso length scales where no material is perfect and defects and interfaces often dominate materials properties. Given the tremendous amount of new knowledge that has arisen from nanoscale science, the science community is now well positioned to address the more complex issues of how functionality develops in a real world material, and importantly how we can design and control the functionality of new materials. This is the topic of the *Mesoscale Science Report.* The report made several specific recommendations for action, all of which are being addressed by BES. Among these are:

• (1) the importance of investment in small- and intermediate-scale instrumentation.

•(2) the development of detectors, sample environments, instruments, and end stations that fully capitalize on the large-scale sources available at national user facilities.

•(3) stimulate multi-disciplinary research groups that include theorists and experimentalists.

and

•(4) workforce (graduate students, postdoctoral fellows, and early stage independent scientists) development for mesoscale science needs to be a priority.

Future Light Sources Report

In January of 2013, the Director of the Office of Science asked BESAC to provide input and advice on the future of U.S. x-ray light source user facilities. I have provided the committee with copies of the resulting report, which was provided to the Acting Director of the Office of Science and the Director of BES in July, 2013. As a part of this study, BESAC carefully evaluated the development of new x-ray light sources around the world. Historically, the U.S. has been in a worldwide leadership position as far as x-ray light source facilities are concerned. This has resulted in continued world leadership for the U.S. in a number of critical areas of science and technology. This fact has not been lost on the science leadership and governments of other technologically sophisticated countries around the world. In particular, the very large investment in new and powerful x-ray user facilities in Europe (Germany, France, Sweden, Switzerland), and Asia (Korea, Japan, China) indicate that they have in fact learned from us the strategic importance of these user facilities. These countries are now investing heavily in a variety of such x-ray user facilities with the aim of taking a clear global leadership position. The BESAC report indicated that it is abundantly clear that, within the next ten years, the U.S. will no longer hold a leadership role in such facilities. The development of new unique facilities will be required for the U.S. to re-establish its world leadership roll. **The BESAC *Future Light Sources* report indicates that a window of opportunity exists for the U.S. to develop a new free electron laser (FEL) facility with unprecedented characteristics, and to develop a unique synchrotron facility upgrade path that would advance and sustain U.S. global leadership of light**

source user facilities. The response of the leadership of BES and the Office of Science to the recommendations of the BESAC report has been both rapid and highly effective. The present worldwide situation with regard to x-ray light sources is a good example of how the **innovation deficit** we face has developed. The 40 year long success of U.S. science and technology discoveries resulting from the suite of BES managed x-ray light source facilities sent a clear message to other technologically sophisticated countries. Their impressive level of investment in recent years and planned investments in the near future has brought us to the present situation. To regain its global leadership in this area, the U.S. needs to act now to make strategically smart investments.

It is important to recognize that the User facilities managed by BES play an essential role in the development and support of the U.S. Energy Sciences workforce. During 2012 the BES light source facilities served over 12,000 users from academics, national labs, and industry. This large user community of active scientists is unmatched worldwide and is a unique U.S. scientific resource that we should continue to support and nurture.

2. Role of DOE national laboratories and national scientific user facilities in the broader American scientific research enterprise.

The DOE national laboratories play an essential role in the American scientific enterprise. As I described previously, the BES managed scientific user facilities provide access to cutting edge scientific experimental capabilities for a

unique U.S. resource—the thousands of U.S. scientists that carry out their work at these facilities each year. In addition, the workforce at the national labs is a national scientific treasure that should be recognized as such. They routinely carry out world leading science that helps to keep the U.S. competitive internationally. The workforce of the national labs also provides a national capability that sometimes does not receive the recognition it deserves. The lab scientists act as highly effective mentors for students and postdoctorals from universities who use the BES managed user facilities. The positive impact of these distinguished scientists on the next generation of U.S. scientists is tremendous. While each of the laboratories has programs in place to support graduate students from universities, the U.S. would benefit from a more aggressive Graduate Student and Postdoctoral Fellowship program that supported university based graduate students and postdoctoral fellows to carry out research at the user facilities.

3. Comments on draft legislative language

I appreciate the opportunity to comment on the draft language for the "Einstein America Act". I will limit my comments predominantly to the section relating to the Office of Basic Energy Sciences, where my background and experience is most relevant. Fundamental science discoveries have been the lynchpin of the U.S. technological leadership that we have enjoyed over my lifetime. I appreciate the strong support that Congress and the American people have always provided for fundamental science. It is my hope that strategic budget decisions can

be made that will address the **innovation deficit** that the U.S. now faces. In light of the long term planning that is required to compete on an international scale, in my opinion, it would be useful if the authorization for the DOE Office of Science were to for a longer period, which would allow for more efficient planning for both large facilities and new and innovative funding mechanisms (e.g., the EFRCs).

I appreciate the language related to the Light Source Leadership Initiative. Continuous attention to the international activity in this area is essential to maintenance of our global leadership position. Indeed, I would hope that it is abundantly clear, from the activities of the last 6—9 months, that a quality process involving close interactions between the Office of Science, BES, and BESAC is already in place and working effectively. Certainly communications with this committee are an essential part of this process. However, I am somewhat concerned that legislatively mandated reporting will provide an additional burden that will act to slow the U.S. response to international developments.

I would like to close by re-stating my sincere thanks to this committee, Congress, and the American people for the longstanding support of fundamental science that has meant so much to the development of this country.

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Chair, Basic Energy Sciences Advisory Committee, U.S. DOE

John C. Hemminger earned his B.S. in Chemistry from the University of California, Irvine in 1971. He obtained his M.S. in Chemistry in 1974 and Ph.D. in Chemical Physics in 1976 from Harvard University. Following two years as an NSF postdoctoral fellow at the University of California, Berkeley and Lawrence Berkeley National Laboratory, he joined the Chemistry faculty at UC Irvine, where he has been Chair of the Chemistry Department and Dean of the School of Physical Sciences. He is presently Professor of Chemistry and the Vice Chancellor for Research at the University of California, Irvine. His research has involved a diverse range of fundamental studies of the chemistry and physics occurring at surfaces and interfaces, with applications to the optical properties of nanostructured surfaces, surface reaction chemistry, catalyst performance, and atmospheric chemistry (with a particular emphasis on the liquid/vapor interface). His research is funded by the Chemistry Division of the NSF, and a program on solar energy that is a joint program of the Chemistry Division, the Division of Materials Research, and the Division of Mathematics, as well as by the U.S. Department of Energy, Office of Basic Energy Sciences. He has published over 195 peer-reviewed papers and mentored over 55 graduate students and 30 postdoctoral researchers. He is a fellow of the American Physical Society, the American Chemical Society, the American Vacuum Society, and the American Association for the Advancement of Science. He has received National Awards from the American Chemical Society (the Arthur W. Adamson award) and from the American Vacuum Society (the Medard W. Welch award). He is a recipient of an Alexander von Humboldt Senior Scientist Award.

Since 2003 he has served as Chair of the Basic Energy Sciences Advisory Committee (BESAC) of the DOE Office of Science. During this period he has helped to develop and has guided the publication of the influential BESAC reports: "Directing Matter and Energy: Five Challenges for Science and the Imagination", "New Science for a Secure and Sustainable Energy Future", "Science for Energy Technology: Strengthening the Link between Basic Research and Industry", the BESAC report "From Quanta to the Continuum: Opportunities for Mesoscale Science", and the most recent BESAC report on "The Future U.S. X-ray Light Source Facilities. He has served as Chair of the Surface Science Division of the American Vacuum Society (1995), the Division of Physical Chemistry of the American Chemical Society (2003), and Chair of the Chemistry Section of the American Association for the Advancement of Science (2007). He presently serves as a member of standing review committees for Brookhaven National Laboratory, Argonne National Laboratory, Oak Ridge National Laboratory, Los Alamos National Laboratory, Lawrence Livermore National Laboratory, Lawrence Berkeley National Laboratory, Stanford University and SLAC, and Pacific Northwest National Laboratory. He is a member of the board of the California Council on Science and Technology.

Chairwoman LUMMIS. Thank you, panel, and now the Members will begin asking the questions, and the Chair yields herself five minutes to begin the questioning.

And of course, I am going to start with something that is near and dear to my heart. As a graduate of the University of Wyoming and later someone who was involved in state government in Wyoming, I was on something called the EPSCoR Coordinating Committee, the Experimental Program to Stimulate Competitive Research, which is a DOE program in part, Office of Science, and it provides limited funding to states that don't receive substantial funding for their universities. Wyoming is an EPSCoR state, as I mentioned, so I was on the panel that got to vet and approve proposed EPSCoR projects and advance them to DOE and to the National Science Foundation for funding recommendations.

DOE has proposed scaling back funding to the states, so my first question is for you, Dr. Dehmer. Many of the EPSCoR states are leading states in energy exploration and energy production, and that is certainly true of my State of Wyoming because of their limited funding and in spite of our massive contributions to the Nation's energy security. What is your view on the role of the EPSCoR program and how can energy-producing states become more competitive in receiving funding through the Office of Science?

Dr. DEHMER. Thank you very much for the question. As it turns out, I know quite a lot about EPSCoR. When I came to the Department of Energy in 1995 to lead BES, Basic Energy Sciences, the EPSCoR program had sort of accidentally had a lapse in funding. It was not funded out of my office. My division directors at the time were so committed to EPSCoR that we took over the EPSCoR program and we funded it out of our base program because of that commitment. So I have known the EPSCoR program for a very long time. It does outstanding work. We are very committed to that program. We work in partnership with all the other offices in the Office of Science and offices elsewhere to see if we can find partnering funds to increase the funding that goes to EPSCoR states. We try very innovative funding mechanisms to see if we can get individual investigators at EPSCoR states to become part of the program. We have worked very hard. The program has a checkered history of funding in the Congress, ups and downs, but we are committed to keeping that stable and to increase it at roughly the same rate that the other base programs in the Basic Energy Sciences increase.

Chairwoman LUMMIS. U.S. Senator Conrad Burns from Montana was very much instrumental in founding the EPSCoR program and was its main champion, so when he was no longer in the U.S. Senate, I think that it dropped as a priority with some Senators, which may have contributed to the fits and starts in terms of funding. So we miss him as a leader in the EPSCoR at least and Congress, and I appreciate your response to the question.

Dr. Simon, what opportunities exist to have DOE and specifically its site offices reduce day-to-day micromanagement of lab operations? And what would the resulting impact be on the labs?

Dr. SIMON. I think we are facing an overall trend of increasing oversight by DOE in many different aspects of our operations. I think in terms of interacting with our sponsors in headquarters with respect to science, the interactions are very good, but when it

comes to issues such as EH&S or other operational opportunities, I think the laboratories would be in a better position if they would have more autonomy, less oversight, and I can mention as an example what I put in my written testimony, the topic of DOE's self-management of Environment Health and Safety. We are just like any other large-scale industrial enterprise and so we could have been easily provided oversight by OSHA yet DOE has its own sets of rules and we have to comply to these rules. These rules are sometimes very restrictive and very burdensome. I have a longer description of that issue that I am willing to supplement in written testimony.

Chairwoman LUMMIS. A follow-up question then. If day-to-day oversight of lab operations is reduced, how can the national labs be held accountable for their stewardship of American taxpayer-supported investments, so you have flexibility, but we have accountability.

Dr. SIMON. Yes. The national labs are operated by companies or universities that have a contract to operate the national lab. The contract has requirements, and these requirements can be enforced and oversight provided through annual reporting mechanisms, through reports back to the sponsors, and can be also reviewed on an ongoing basis. That is different from describing on a daily basis on how particular instances of our operation need to be carried out in terms of what level of inspections need to be done, what level of support needs to be put into a particular operation. So I think the outcome-oriented management is important as opposed to theoretical operational management.

Chairwoman LUMMIS. Thank you, Dr. Simon.

I gave myself a very generous fiv minutes, and will do the same for our Ranking Member. I recognize the gentleman from California.

Mr. SWALWELL. Thank you, Chairman Lummis.

The research community often cites sustained growth and predictable funding as being among their top priorities. Not surprisingly, private industry cites predictability as one of its top priorities, and in necessity, if we really want the United States to continue to be a world leader in technology and innovation.

Dr. Hemminger's testimony specifically refers to the innovation deficit that the United States is experiencing, and as I discussed in my opening statement, while I appreciate the majority's draft and its aims to improve the authorization of several important programs and activities carried out by the Office of Science, I have concerns about the draft's funding profile. It supports budget levels that are below research inflation rates so they are effectively cuts, and nine percent below the bipartisan Senate Appropriations Mark for the Office of Science. I am also concerned that the funding profile in this draft runs for only two years rather than a much longer time. I would prefer something like five years to give more certainty to the laboratories and those partners in the Office of Science.

Dr. Hemminger, do you think that a short-term two-year reauthorization that cuts the Office's budget, provides the certainty and stability that the research community needs, and how does this help to increase the innovation deficit?

Dr. HEMMINGER. Thank you very much for that question. You know, I think that it is widely recognized that the predominant programs that are run by the Office of Science and particular the Office of Basic Energy Sciences are long—are addressing long-term questions and long-term issues. These are not science questions that one can expect answers to in very short periods of time, and I think that the only way that a short-term reauthorization works is with the expectation that the U.S. government isn't going to go out of business and fall off a cliff and so on. So, I think it certainly would be advantageous to have a longer reauthorization bill, and I think this is particularly a problem or an issue with respect to the large science facilities. In my written testimony, I pointed out the issue of the international competition with respect to our global leadership for X-ray light sources and other facilities, and these are really major long-term projects that require stability in terms of funding and authorization. I would encourage the Committee to support that.

Mr. SWALWELL. Thank you, Dr. Hemminger.

Dr. Simon, what are your thoughts on funding and length of funding, or length of authorization?

Dr. SIMON. As I said in my opening statement, the national laboratories have long-term projects in research and have large-scale facilities that require a predictable, continued operation. It is very difficult in both instances to have a very highly variable budget that changes from year to year and that is not predictable. With respect to large facilities, the issue is that ongoing upgrades, plans may need to be postponed at an increased cost to the taxpayer later on. With respect to research projects, the high variability in funding makes it very difficult to plan personnel, and we are talking here about highly critical talent that if it is junior researchers, if postdocs see that there is uncertainty about funding, about the longevity of a project, they will go elsewhere and leave the national lab and weaken our innovation ecosystem. Thank you.

Mr. SWALWELL. And Dr. Simon, could you talk a little bit about some of the other Federal agencies and private-sector users that you have at Lawrence Berkeley? We have heard that DOE labs are using—are having other agencies like NIH, NSF and NASA use their laboratories, and I know from touring LBL that there are private-sector partnerships as well. Can you talk about who those users are and how they are benefiting the technology transfer to the private market?

Dr. SIMON. Thank you for the question. So let me first talk about other Federal agencies. The national user facilities that are operated by the Office of Science are available to all researchers, that is, university, national labs and industry researchers, so we have, for example, at the Advanced Light Source in Berkeley a large number of researchers funded by NIH. These are biologists who are interested in determining the structures of large biomolecules of proteins. There are significant examples of major progress that has been obtained using the DOE facilities. For example, a research project that was just completed a couple months ago is looking at the structure of the influence of the flu virus. As you know, the viruses are mutating rapidly and there is still a quest for finding a common vaccine that would address all these flu viruses. So in

order to understand this, one has to look at the structure. There was a major project that was NIH funded that used the ALS to identify the structure of many of these viruses.

With respect to NASA, I could mention an example of a collaboration between the Department of Energy's Office of High Energy Physics, with NASA to collaborate on an astrophysics project called the Planck project, which is an exploration of the cosmic microwave of background radiation where both agencies have worked together, and the supercomputing center, NERSC, in Berkeley is actually the data repository for the Planck data.

Mr. SWALWELL. Thank you. And Dr. Simon, I have gone over my time.

Dr. SIMON. I haven't gotten to industry but I will be happy to——

Mr. SWALWELL. Yes, and hopefully we can get back to that. He is so passionate, he has so much to talk about, Chair. Thank you.

Chairwoman LUMMIS. And we are delighted for that, so we are going to have a generous clock today.

The Chair now recognizes Mr. Hultgren, the gentleman from Illinois.

Mr. HULTGREN. Thank you, Chairman Lummis.

Thank you all for being here, and I really do appreciate the work that you are doing. I hope you know from us, certainly from me, my passion for the work of the Office of Science and how key the work of the Office of Science is to determine our competitiveness on the world stage, and just absolutely convinced that we must right now be committed to maintaining our leadership in basic scientific research so that we can continue our leadership on the world stage as far as being an innovative nation going forward. I also have the great privilege of representing Fermilab, many of the brilliant scientists at Fermilab, Department of Energy employees at Fermilab, as well as many scientists over at Argonne. So I see firsthand the incredible impact that our laboratories have on the communities where they are located but much larger than that, the impact that they have on our university systems. I travel to all of my universities around Illinois and I am just amazed at the incredible opportunity that our students have working with our national laboratories to do truly groundbreaking research, and what a great opportunity. But then even beyond that, to see something like Fermilab where I think the numbers I saw was 39,000 K–12 graders are impacted every single year by Fermilab through programs, through work with teachers, by scientists going into the schools, incredible impact, and I am absolutely convinced that we must continue our commitment to basic scientific research at our national laboratories if we are going to be a great nation going forward with great opportunities for our kids and our grandkids to be able to learn and study here but also apply that knowledge for new discovery here in America, so thank you.

A couple questions I had. Dr. Dehmer, I wanted to ask you your thoughts on the long-term future of the Department's High Energy Physics program as it continues to regain its leadership role on the international level. There is no question that the United States was essential in experiments at CERN with programs like the LHC and Atlas. But I wondered what is next and what your thoughts are on the Long Base Neutrino Experiment and our unique underground

research space in South Dakota and Minnesota? What does America have to lose if we do not begin to act on this, and how can we leverage international funding to realize the potential discoveries that it has to bring?

Dr. DEHMER. Well, thank you for the question. I spent 23 years at Argonne National Laboratory just down the road from Fermilab. Fermilab is one of our most important laboratories. As you well know, it is transitioning now from work at the energy frontier to work in the so-called intensity frontier. The accelerator and detector expertise at Fermilab is going to be critical to make the United States world leading in the intensity frontier. We need very intense beams. We need very high-precision detectors in order to do that. Fermilab will be at the forefront of doing that. Right now, as you probably well know, there was a very large meeting called the Snowmass Meeting in Minnesota that went on for a couple of weeks with about 500, 700 participants. That is going to be followed very closely now by an advisory committee study. Our expectation is that that study will be done in the spring, and that is going to inform not only the future of high-energy physics but we hope that it will also endorse a very vibrant future for Fermilab. As you well know, there is a new laboratory director at Fermilab, Nigel Lockyer, who is extremely talented, very aggressive, and so we are looking forward to a very good future for high-energy physics and the laboratory.

Mr. HULTGREN. Good, and I hope there is a specific commitment with the Long Base Neutrino Experiment. I think we are in a unique position there on the forefront. If we let that slip away, there are certainly other nations that are willing to step in, like has happened in other areas where we haven't followed through on opportunities that we have had, and we have seen focus come away from America and go over to Europe or other places. I really think it is so important that we don't let this slip away.

Dr. Dehmer and Dr. Simon, if I could get your thoughts? Earlier this year, DOE prepared a roadmap to develop exascale computing systems that I had the opportunity to sit down and discuss with Secretary Moniz on. I wondered if you could summarize the key findings and recommendations and also let the Committee know what ways DOE and non-DOE stakeholders can collaborate and utilize this capability?

Dr. SIMON. Thank you for the question about exascale. Let me state first that I believe moving towards exascale is an incredibly important opportunity for the Department of Energy Office of Science but not just the Office of Science, other parts of DOE, NNSA and the U.S. research community in general to maintain leadership in high-performance computing. It is the path towards exascale, and not exascale in and of itself that is important. The reason why that is, is because I think there are fundamental changes that are currently happening in computer technology. You all are aware of technology shrinking, become more available at the iPhone level. These type of changes fundamentally alter the landscape of computing. What exascale really is about is envisioning how the computer landscape will look in 10 or 15 years. A good analogy is the early 1990s when there was a High Performance Computing Initiative, HPCC, that was a very well-coordinated,

well-funded initiative with national coordination which allowed all the agencies that have interest in computing to work together. I still look back to this time and say this should be a model for exascale. We should look at this as a challenge that is not just for the Department of Energy but for other agencies as well because whoever will control this technology in the near term will have a long-term economic advantage in the computing world.

Mr. HULTGREN. I agree with you.

My time is expired. I do have some more questions, if it would be all right if we can follow up in writing and get your response. Dr. Dehmer, we would love to hear your thoughts on the exascale computing work that we see as important but also some other things. With that, I yield back. Chairman, thank you so much for your generosity.

Chairwoman LUMMIS. And thank you for your expertise and enthusiasm for this topic. We are always impressed with your presence and your commitment to this subject, so Mr. Hultgren, my compliments.

I will now recognize the gentleman from Illinois, Mr. Lipinski. He and I came up on the elevator today and we were both concerned that we were enthusiastically rushing to this Committee, so the Chair recognizes the gentleman from Illinois.

Mr. LIPINSKI. Thank you. There are so many things to talk about here. Let me quickly get to it, and some things I might leave for follow-up questions for the record.

I first want to say that I am glad to see that Congressman Hultgren's bill, which I cosponsored, on high-performance computing has been incorporated into the discussion draft. I know it is vitally important that we keep up investments in high-performance computing that push the boundaries of what is possible and keep us on a path towards exascale computing as we were just talking about. I have seen firsthand how impressive these high-performance computing projects are by visiting the Mira supercomputer at Argonne, which is in my district, so it is great to have Argonne there. It is a great example of what we can do and what we should be doing more of. I may come back or maybe for the record ask Dr. Dehmer about the ASCR program, but I just wanted to move on to talk about tech transfer.

It has been one of my top priorities since I have been in Congress, making it easier to get these research findings that then become new technologies, new inventions, get them out of the lab and into the market. Our national labs have been real leaders in this space as many of them have taken money that they receive from licensing agreements and put it towards funds that help accelerate the commercialization of new technologies. Still, I think more can and should be done, both at the labs and at DOE.

I want to ask Dr. Dehmer, could you tell—can you talk about how the Office of Science approaches technology transfer and how you look to partner with the labs primarily funded by the Office of Science in these activities?

Dr. DEHMER. Well, I will tell you briefly what the Office of Science is doing in our SBIR program. We have a new part of that program called TTO, Technology Transfer Opportunities, and it allows applicants to the SBIR program to use technologies or R&D

results from our laboratories in their work and the SBIR grants, and having looked just recently a couple of days ago at the latest funding opportunity announcement from the SBIR program, there are dozens of technology transfer opportunities noted in that for applicants. So we are aggressively working with our laboratories and also our universities but mostly the laboratories to take the results of their R&D and move them to small businesses.

I also want to comment on what the Secretary is doing, Secretary Moniz. He is very interested in reducing barriers to the laboratories working with small business and industry, and his lab policy council, which was just established and had its first meeting last week, was devoted about 50 percent of the time to talking with lab directors and others about how we can reduce barriers and make it easier to do exactly what you are saying.

Mr. LIPINSKI. Very good. It is great to hear those things, and I think there is—I am sure there is more that we can do. One thing I am interested in is having DOE participate in the Innovation Corps program, and that is something I would like to continue to talk about.

One other thing I wanted to get to right now is flexibility for the labs, and I think there is a need to have more flexibility. I am glad to see that the language in the bill expands the use of ACT agreements that can be entered into between labs and small businesses without an extra layer of review from the DOE. It is a good start, and I applaud DOE for working with the labs on the pilot program for these agreements. But I want to ask Dr. Dehmer if DOE is looking at other areas from tech transfer to facilities construction where perhaps the labs could be given a bit more leeway in what they are doing for the more minor decisions. I understand the need to follow DOE's lead on larger strategic investments, it is always going to be there, but in terms of giving a little more flexibility to the labs.

Dr. DEHMER. Yes. That is one of the things that has actually concerned me for a long time. Sometimes it is called atomization of budgets where budgets are put out in very small amounts. One of the things that we have done in the Office of Science is, we have created funding constructs that put money to the laboratories, in fact, even to the universities, in much larger amounts, and having a larger amount of funding to work with gives the labs that flexibility. And examples are the Nanoscale Science Research Centers, five of them, that we put in place about ten years ago now, the first one not quite ten years ago. That is a $25 million budget item, and the labs have flexibility to use that subject to annual or biannual or triannual review. The Energy Frontier Research Centers, the Bioenergy Research Centers and the Energy Innovation Hubs are all constructs that put funding to the performers, in many cases largely to the laboratories, in chunks of money that give the lab just this kind of flexibility and discretion in spending that you are talking about. I think that is something that I started almost ten years ago when I was in Basic Energy Sciences and I am pleased to see is continuing. I also don't like to see too many constraints put on laboratories with too small amounts of money.

Mr. LIPINSKI. Thank you very much. And just very briefly, I just want to bring everyone's focus back to two things that Dr. Simon

said. One is the great cooperation we have in this country—universities, the national labs, industry. We need to not only appreciate that, we need to do what we can at the Federal level to help to continue and to help grow those, and I am glad Dr. Simon pointed those things out.

And also the last thing that you had said in your testimony, Dr. Simon, about the future and what the future looks like for a young scientist today, and I think we all need to focus on that and do what we can to make sure that it continues—we continue to be the place that young scientists want to come to and to stay. Thank you.

Chairwoman LUMMIS. I thank the gentleman from Illinois, and the Chair will now recognize the gentleman from California, Mr. Takano. You know, our California Members make that long trek every week that our witnesses from California made today, and so they are grateful for your willingness to come this far. I now recognize Mr. Takano.

Mr. TAKANO. Thank you. I know our Chair travels from the great, wonderful State of Wyoming, a beautiful state. Thank you, Madam Chair.

I am fortunate to represent UC Riverside, a top-notch research university, sister school of an empire that includes both Berkeley and Irvine. I want to get straight to the questions.

Dr. Dehmer, in the majority's draft authorization of the Office of Science, the Biological and Environmental Research Program is directed to "Prioritize fundamental research on biological systems, genomic science over the rest of the portfolio." This is clearly a way to implicitly say take money from climate and environmental research. Do you support this language in the discussion draft?

Dr. DEHMER. No, we do not support that. The climate and environmental sciences part of Biological and Environmental Research is extremely important, and we do not want to disadvantage that in the way that the language in the majority bill has been interpreted.

Mr. TAKANO. Thank you. Dr. Simon?

Dr. SIMON. I concur with this answer, and I would just like to add that the environmental and climate research in the Office of Biologic Environmental Research is an important, integral part of the DOE mission. We shouldn't really think of, say, climate as a standalone enterprise but think about how it interacts with other parts of the program. For example, climate science allows us to predict rainfall, precipitation in the West. That ties into the availability of water. The availability of water again has energy impacts in terms of how hydropower will be generated, how water will be used in energy technologies. So the Department of Energy is uniquely situated to explore not just climate itself but the interaction of climate with the ecosystem, and in a situation where this fundamental research can lead to important insights for our future.

Mr. TAKANO. Thank you.

Dr. Hemminger, I believe you sort of stated your opinion in your opening statement. Would you care to add anything?

Dr. HEMMINGER. No, I just want to say that as I said in my opening statement, I think it is a mistake to try to legislatively prioritize topics within the Office when important topics such as

the environmental sciences at sort of a really molecular level of understanding are so important.

Mr. TAKANO. These sciences are so important to my district and southern California in general where there is actually seven or eight Congressional districts the size of several states that suffer from air quality issues, and our understanding of the way in which environmental—how the environment interacts with climate is very important to us.

Dr. Simon, you mentioned the fact that you became an American citizen, that you saw this country as a place for you and a future for you in science, and you said you could no longer really say that to a graduate student today or—I am assuming that is what you were thinking. Can you explain a little bit more what you were talking about?

Dr. SIMON. Thank you for the question. I think if I look at the steady state today and if I look at what the research facilities are, what the infrastructure is, what our educational institutions are, what our opportunities are to work with industry, how industry is working with us, America is still very clearly number one. However, what I am concerned about is the trend, and just to give a very recent example, if we have issues such as sequestration, which means that we have to look at future staffing, if we look at the partial shutdown where uncertainty goes through the system, what we are signaling to the next generation of scientists is, is that the future of science in the country is no longer as certain as it was. We are sending a very strong signal saying yes, there is a great infrastructure here, there is the opportunity here to work with top minds in the field but we cannot guarantee you that 30 years from now that situation will be the same because if we are on a path of continued reduction in funding, continued uncertainty about the longevity of some of the research projects, somebody who has to stake a 30-year career in front of them will have to very carefully look where he or she will go.

Mr. TAKANO. So many of our top, bright graduate students might place a bet on other countries that seem to have a different trajectory.

Dr. SIMON. Yes. I think we are at an inflection point where it could very well be that some of our brightest researchers will look elsewhere, in particular looking at Europe. From my personal experience, I would say particularly in my field, to put this in historical context, in 1980 there was no doubt about the differential between what was happening in America and what was happening in Europe. Today I would say Europe has pulled up and is in many areas even and in some areas even ahead of us.

Mr. TAKANO. Thank you so much for your testimony. I yield back.

Chairwoman LUMMIS. I thank the gentleman, and we will have an opportunity for those of us who are here to ask a second round of questions, and we are going to limit the time, so the Chair recognizes the gentleman from Illinois, Mr. Hultgren, who has a bill on the Floor, and we are delighted you were able to stay this long. Thank you.

Mr. HULTGREN. Thanks, Chairman.

Dr. Dehmer, I will follow up with the question I had asked Dr. Simon just in regards to exascale computing, if there is any shortly key findings, recommendations or if there are ways that DOE and non-DOE stakeholders can collaborate to utilize this capability?

Dr. DEHMER. Yes. Let me just say what is happening inside DOE. Secretary Moniz—you said you spoke with him—is very strongly supportive of this, and he is having NNSA and the Office of Science work collaboratively and collaboratively with the community to make sure that the exascale program, and as Dr. Simon said, it is not an endpoint, it is a journey, a ten-year journey to a computer this large, is successful. He has also asked his advisory board, the Secretary of Energy Advisory Board, to listen to the presentations from the Department and from others and to provide him with advice on the path forward. This is one of the very highest priorities in the Department of Energy right now.

Mr. HULTGREN. Okay. Thank you.

Dr. Dehmer, different subject. In your testimony, you stated that HEP is the steward of accelerator R&D technology for DOE. I wonder if you can just discuss the interagency collaboration on this technology, where it lies in the draft legislation and the benefits accelerator research has for America.

Dr. DEHMER. The Office of High Energy Physics has been very aggressive in the last couple of years reaching out to others—NIH, the medical community, all communities that use accelerators—to find out how we can help them. As you know, the State of Illinois built IARC at Fermilab, and that is another way that we are going to reach out to non-traditional users of accelerators to see how we in the High Energy Physics program through the laboratories can help others who need accelerator technology but don't have the expertise to do it themselves.

Mr. HULTGREN. Thank you. Last question I will ask, Dr. Dehmer. There is a couple different parts to it. The United States is currently a partner in ITER, a more than $20 billion international project to demonstrate the concept of fusion energy. Unfortunately, this project has been plagued by delays, increased cost estimates and poor project management, and I understand more bad news may be on the way in terms of our European partners' ability to meet their project obligations. Dr. Dehmer, do you have full confidence in the construction and financing of ITER within a reasonable time frame and cost structure?

Dr. DEHMER. Well, let me answer that in a slightly different way. As you know, in the 2014 budget which is now before Congress, the Department of Energy capped its contribution to ITER at $225 million a year with a $2.4 billion cap to get it to first plasma. We are awaiting the results of a couple of reviews now. One of them is an international review of the management of the project at the International Organization, the IO, and the other is an Office of Project Assessment, sometimes called a Lehman review, and based on the results of those two reviews, we will take another look at how we are approaching ITER.

Mr. HULTGREN. You kind of touched on this, but I wonder if you could maybe go a little bit further and just describe any upcoming project milestones and how the Department will evaluate its future participation in contributing to ITER?

Dr. DEHMER. Well, we are responsible—the U.S. part of ITER, the U.S. project office, USIPO, is responsible for certain deliverables, and we review progress toward meeting those deliverables on a regular basis through the Office of Project Assessment, and that tells us about how we are doing. The so-called management assessment, which won't be released until late November, will tell us a little bit about how the ITER project office in France is doing, and again, based on the results of those two reviews, we will take a look at what our position is going to be.

Mr. HULTGREN. What were the dates on that again?

Dr. DEHMER. Late November is the council meeting, and the management assessment will be briefed to the ITER council at that point.

Mr. HULTGREN. Okay. I think for us, and you understand this, our responsibility is certainly to see the Department do well and be in the forefront of some important work but also making sure that we are being responsible for the taxpayer dollars, so just kind of in conclusion, I just ask, will you assure the Committee that you will continue to be vigilant in protecting taxpayer dollars from waste and cost overruns specifically associated with ITER to the point of considering U.S. withdrawal from the project if necessary?

Dr. DEHMER. Yes, we will do that.

Mr. HULTGREN. Thank you. Again, thank you all for being here, and thank you, Chairman, for allowing me to jump ahead a little bit in the line here. Thank you.

Chairwoman LUMMIS. I thank the gentleman.

Mr. Swalwell.

Mr. SWALWELL. Thank you, Chairman Lummis.

Dr. Simon, could you complete your remarks from earlier about private industry partners that your laboratory has been working with and how you see their work transferring out to the private sector and creating jobs, helping the economy, making us more energy independent?

Dr. SIMON. Thank you for the question. I would like to follow up on this. Yes, there are of course several individual collaborations of our laboratory with private industry. There are the standard ways of transferring technology through licensing and intellectual property rights agreements. I could mention a couple of exciting examples. Dr. Dehmer mentioned previously the Nanoscience Centers. We now have ten years later the first examples of technology coming out of Nanoscience Centers that is actually used in industry in terms of small company startups but using very innovative ideas to build new products. I can mention a small company that has just started, Heliotrope, that is using a nanocoating on windows that makes windows electrochromic so it can switch from on and off. In winter you make windows bright so sun can go in and heat stays inside and in the summer you switch in reverse, and this is by the flip of a switch. Of course, this is technology that is proven in the lab. It will take years to make it a real product. But this is the path that we have from basic research at the lab to an actual innovation that could change maybe in ten years or so how we build houses.

More fundamentally, I think I would mention two other things. One project, one area is so-called work for others. The labs engage

in projects that are funded by industry. It is a very important element because it allows industry to work directly with us, sponsor work at the lab and benefit from the investment that the Department of Energy has made. It would be very desirable if these work for others projects could be made a bit easier to implement and maybe the labs would have authority to in particular sponsor small work for otherd projects quickly without DOE oversight. That is important because often we work with small companies that cannot wait for eight or nine months to get approval. Those companies need commitments from VCs or have other constraints. So speed is of the essence.

A third area that I would like to mention is the use of national user facilities. These are open to industry. Industry has worked with the national user facilities. As an example, the Advanced Light Source has a very long-term agreement with Sematech, exploring extreme ultraviolet technology for future generations of chips. Large companies and consortia like Sematech know how to do this. I think what we need to do is find a way of getting small and medium sized enterprises access, better access to our facilities, again, reducing paperwork, making it easy and efficient and possibly even providing support for small and medium sized companies to access the facilities.

Mr. SWALWELL. Great. Thank you, Dr. Simon, and I yield back.

Chairwoman LUMMIS. I thank the gentleman, and I have kind of a follow-up question about the EINSTEIN America draft bill as it relates to signature authority on agreements for non-federal entities. The discussion draft delegates signature authority on agreements under 500,000. Is there a threshold which may provide for added flexibility to the national labs while preserving the Department's oversight responsibilities for larger projects? And I open this question to any of our panelists.

Dr. DEHMER. Yes, we noted that provision, and that is something that actually I think we may have to talk with general counsel about because that adds to the contract of the laboratory, and I am not sure what role DOE can relinquish in doing something like that. I understand the sense of this, that it is to give the labs more flexibility and more freedom to work quickly. You know, as I mentioned earlier, one of my goals is to give the labs more flexibility in research dollars by putting out dollars in larger amounts and letting the M&O contractor manage that. I think the same philosophy holds for work for others in technology transfer, and I think there are mechanisms that the Secretary would like to put in place to do that. I am not sure that this is one of them but we will certainly explore it.

Chairwoman LUMMIS. Dr. Simon, is 500,000 a good threshold from your perspective?

Dr. SIMON. It is certainly a good threshold but I think a million would be better.

Chairwoman LUMMIS. Okay. And I hear you. Thank you for your candor.

Dr. Hemminger, any thoughts on this?

Dr. HEMMINGER. Yeah, I just agree with Dr. Simon. You know, coming from the University of California, which is part of the con-

tract management for several of the labs, I think this would be an important step if it is legal, and——

Chairwoman LUMMIS. Well, we make it legal.

Dr. HEMMINGER. Yeah. Very good. You know, I think that moving in this direction would be positive.

Chairwoman LUMMIS. Let me ask just as my final question, is there anything that you would like to share with us that we have not asked? So I leave the option to say something that is a burning answer that you wish you could leave us today with.

Dr. DEHMER. Well, I would like to add something to the discussion that we have had already today on the funding levels in the EINSTEIN Act. One of the things that I noted over the weekend when I was poring over numbers was that the authorization in the 2010 COMPETES Act for Fiscal Year 2013 was a hair over $6 billion for the Office of Science, and when we see something like that, we tend to plan toward something of that order of magnitude. The actual appropriation was $4.6 billion, so we are significantly below what the authorization was, and it is very hard to plan. When I was the director of Basic Energy Sciences for all those years, for 12 years, I carried with me a single sheet of paper and that single sheet of paper was a ten-year projection for what the Basic Energy Sciences program would do in construction and in research. It was a single Excel spreadsheet. And those years, we didn't have a huge amount of funding but we knew what was coming or we could plan what was coming. And today there would be no way that you could carry a spreadsheet like that because things change so much.

Chairwoman LUMMIS. Dr. Simon?

Dr. SIMON. Thank you for the opportunity to comment freely. I of course support very much what Dr. Dehmer said. I would like to draw your attention to another topic that is very, very important for the future. Many of our national laboratories were created and formed in the time after the second World War, and are really still in the legacy of the Atomic Age as far as their physical infrastructure is concerned. We have, for example, in Berkeley Lab, the average age of buildings is more than 50 years. We are an 80-year-old lab, so you can really see from this that there was a big building boom in the 1950s and 1960s and we are still in buildings that are by now outdated and in many cases no longer safe. There is a program in the Office of Science called the Science Lab Infrastructure, which allows for gradual renovation of buildings, upgrades and also doing important things in California such as earthquake safety. We are very supportive of this program because it is the best way of accomplishing a gradual upgrade of very old and aging facilities.

In addition to that, of course we understand that we are in a time of very constrained budgets. It would be very helpful if we could find innovative and quick ways to use other sources of funding. For example, the laboratories would be very interested to use third-party financing for buildings and we would like to work with the Office of Science and DOE to find quick ways to accomplish this within the existing framework. So, infrastructure is as important as people and scientific facilities.

Chairwoman LUMMIS. Dr. Hemminger?

Dr. HEMMINGER. Thank you very much for the opportunity to make some general comments. I would like to come back to the

concept of the importance of the Office of Science with respect to dealing with what I call the innovation deficit. I think this is a really critical issue for the United States, and we have not yet approached, I think, the problem that led, for example, to the brain drain out of Europe after World War II, but I think we have—we are seeing a situation which could in fact lead to that, as Dr. Simon has mentioned.

One of the things that I think has not yet been pointed out is the tremendous and unique capability or asset that the United States has with respect to the staff at the national labs, not just the staff but the users at the national lab facilities. The light sources, for example, that the Office of Basic Energy Sciences manages have on the order of 12,000 users annually, and this is really a unique, worldwide asset that needs to—that the United States has that we should continue to support, and I guess I would like to finish just by thanking the Committee again for its strong support for science over the years, and for the opportunity to be here today.

Chairwoman LUMMIS. I thank the gentleman and the panel, and certainly you passed our test, Dr. Hemminger. We have those bells and whistles come on while you are speaking so we can test your ability to focus, and you passed our test swimmingly. So thank you very much.

The Chair now recognizes the gentleman from California, Mr. Takano.

Mr. TAKANO. Thank you, Madam Chair.

Dr. Dehmer, as a former high school teacher, improving STEM and STEAM education is one of my top priorities. We must ensure we are preparing our students and teachers to succeed in the 21st century. Overall, what will the role of the Department of Energy be in furthering STEM education, especially as it relates to meeting future energy workforce development needs?

Dr. DEHMER. Yes, the major role that we play is the support of graduate students through our grants program. However, we also have a program called Workforce Development for Teachers and Scientists. I know this program well because I am actually the director of it, and in addition to the other things I do. That program places a thousand people a year at the labs for internships. It is undergraduate students, a new graduate program that will place graduate students for periods of three months for up to two years at the laboratories to do their work, and visiting faculty and students that they might bring with them. So through this program, the Department of Energy Office of Science hopes to get students and faculty engaged in laboratory research, seeing the laboratories as an excellent place to have a career or an excellent place to collaborate with staff at the laboratories.

Like Dr. Simon, when I was getting out of graduate school, I really had no knowledge of what the laboratories were or what they did or what the workforce was like. I had a postdoc at Argonne National Laboratory. I thought it would be a couple of years. It turned out to be 23 years. And unless we bring people into the laboratories and let them understand what those laboratories do, I don't think that we will have as vibrant a workforce as we might have. So this is a very important program to us. STEM is very important to us.

Mr. TAKANO. The Computational Science Graduate Fellowship program, which is a partnership between the DOE Office of Science and the DOE National Security Administration is widely considered to be a success in meeting the DOE's national laboratories' computational science workforce needs. Under the President's budget proposal, will this program still be administered by the NSF?

Dr. DEHMER. We don't know what the implementation of the consolidation of the STEM programs is going to look like because that hasn't been fully explored. I agree with you that the Computational Sciences Graduate Fellowship program is one of outstanding fellowship programs that we have run for over 20 years. It has reviewed outstandingly, and it is essentially the who's who of computational sciences have gone through that program. So that is one of our concerns in the consolidation.

Mr. TAKANO. Great. Madam Chair, I have no further questions. I yield back.

Chairwoman LUMMIS. I thank the gentleman. I thank all of our Members who attended this hearing today, and I particularly want to thank the witnesses for your valuable testimony. The members of the Committee may have additional questions for you. I know Mr. Hultgren had suggested he may follow up with some of you in writing. There may be other members of the Committee who will do so. The record will remain open for two weeks for additional comments and written questions from members, and with our gratitude for our fine panel today, for your attendance and for your thoughtful responses to our questions and our gratitude once again, this hearing is adjourned.

[Whereupon, at 12:00 p.m., the Subcommittee was adjourned.]

Appendix I

ANSWERS TO POST-HEARING QUESTIONS

ANSWERS TO POST-HEARING QUESTIONS

Responses by Dr. Pat Dehmer

QUESTIONS FROM REPRESENTATIVE CYNTHIA LUMMIS

Q1. What opportunities exist to have DOE—and specifically its site offices—reduce day-to-day micromanagement of lab operations?

a. How can the Department balance the need for strong oversight and protection of taxpayer funding with providing additional flexibility to the National Labs?

A1. The Office of Science (SC) site model relies on an approach placing accountability on the M&O contractor for proper conduct of work, while providing federal oversight to ensure the contractor is operating safely and within requirements. This structure allows maximum flexibility for the Lab in executing DOE's mission while ensuring that federal funds are properly utilized consistent with Federal statutes and DOE requirements. SC also employs a robust oversight system to ensure that SC National Laboratories are operated in a manner to maximize proper operations, especially in safety and security.

Q2. Please summarize Secretary Moniz's vision for the National Lab complex. Specifically, how does the proposed creation of the National Laboratory Policy Council and the National Laboratory Operations Board fit into that vision?

a. How will these new entities, which have different lines of reporting, be coordinated with the Office of Science and the Under Secretary for Science and Energy?

A2a. The National Laboratory Policy Council (Council) and the National Laboratory Operations Board (Board) were established by the Secretary to contribute to an enterprise-wide effort to identify, manage, and resolve issues affecting the strategic guidance, management, operations, and administration of the National Laboratories.

The Council, chaired by the Secretary, provides a forum for the National Laboratories to provide strategic advice and assistance to the Secretary in the Department's policy and program planning processes and for the Department to provide strategic guidance

on National Laboratory activities in support of Departmental missions. The Council's membership includes Directors of the National Laboratories, the Department's Under Secretaries (including the Under Secretary for Science and Energy), and Program office Assistant Secretaries (including the Director of the Office of Science).

The objectives of the Board are to strengthen and enhance the partnership between the Department and National Laboratories, and to improve management and performance to more effectively and efficiently execute the missions of the Department and the National Laboratories. The Board is chaired by the Under Secretary for Management and Performance and its membership includes the Deputy Under Secretary for Science and Energy, Program office Chief Operating Officers (including the COO for the Office of Science), and representatives from the National Laboratories' Chief Operating Officers and Chief Research Officers.

Both the Council and the Board will enable consistent and well-considered policy decisions affecting the Department's Laboratory complex. These efforts are designed to strengthen the relationship and interactions between the Department and the National Laboratories in ways that work toward eliminating stovepipes and streamlining operations to better achieve DOE's mission, maximize the impact of federal investment in the laboratories, and to better respond to opportunities and challenges.

Publication of consistent Departmental guidance across all Program offices will serve to increase the Department's ability to best match capabilities and resources present in the National Laboratories. The Council and Board provide a mechanism to give the Secretary and Senior Leaders consistent recommendations with widespread input from

all major DOE programs and the National Laboratories. The mixture of contractor and federal membership ensures that diverse viewpoints are represented and coordinated in recommendations made to the Secretary and Senior Leaders in support of DOE's mission.

Q3. Section 109 of the draft legislation directs the Secretary of Energy to coordinate with other Federal agencies to reduce external regulation of National Lab nuclear safety and occupational and health responsibilities. Does the Department support the orderly transition of regulation to other Federal agencies?

a. Has the Department considered this transition previously?

b. How can this transition from DOE regulation to other Federal agency regulation be conducted in an orderly and effective manner?

c. Will the Department commit to working with the affected stakeholders to address this issue?

A3. The Department studied approaches for external regulation in the 1990's and 2000's, and in consultation with both the NRC and OSHA, ultimately found that it would be costly and time consuming, without any significant safety improvement. The Department, NRC, and OSHA found no compelling safety or financial justification for change. All prior reviews were performed before the Department streamlined its internal safety management directives that are applied through contracts. The Department of Energy therefore does not support a transition of safety regulation of its national laboratories to other Federal agencies. In conformance with prior congressional direction and the provisions of the Atomic Energy Act, the Department has established an effective and efficient approach to regulating nuclear safety and occupational safety and health of its national laboratories and other management and operations contractors that is suitable to its highly diverse operations and its unique safety hazards. The Department of Energy has been, and remains, fully committed to

working with affected stakeholders to improve the management of nuclear safety and occupational safety and health at our national laboratories.

Q4. Currently, the Department must approve all technology transfer agreements between National Labs and non-federal entities, including Cooperative Research and Development Agreements (CRADAs) and non-Federal Work for Others Agreements. In 2011, the National Lab Directors Council sent a list of burdensome policies and practices to former Secretary Chu, and this approval process was the number one item on the list.

a. What is the Department's position on delegating signature authority for some technology transfer activities to the National Labs? What concerns does DOE have that may prevent this recommendation from being fulfilled?

b. The EINSTEIN America discussion draft delegates signature authority on agreements under $500,000. Is there a threshold which may provide for added flexibility to the National Labs, while preserving the Department's oversight responsibilities for larger projects?

A4. The Department has several concerns with the recommendation to delegate signature authority to the National Labs including Federal contracting statutory requirements and the need for Federal fiduciary oversight of these facilities. The primary role of the DOE Laboratories is to perform mission work for DOE. To that end, DOE must ensure that Laboratory personnel and resources are available to perform the DOE mission work before they are committed to perform work for outside sponsors. Such prioritization of resources requires DOE's pre-approval of work. Delegation to Laboratory Directors would result in the commitment of Government resources without prior Federal review of the specific agreements. Moreover, any funding/work commitments through these agreements require modification of the laboratory contract. The suggested delegation of authority would allow unilateral laboratory contract modification by the contractor, thereby abrogating the Federal government's fiduciary

responsibility. This approach is clearly contrary to established principles of functions and best practices that have been accepted across Federal agencies as inherently governmental, as codified in the Federal Acquisition Regulations (FAR), 48 C.F.R. Subpart 7.5.

Other concerns related to this type of delegation are when the laboratories engage foreign sponsors under these technology transfer arrangements and there is no DOE review of the activities. The arrangements with foreign entities must involve careful consideration of intellectual property (IP) rights disposition, national security concerns, and export control issues. This delegation of authority would remove the Department from the review process thereby rendering it unable to evaluate the IP ownership disposition and potential national security concerns before the laboratory makes contractual commitments with a foreign sponsor.

In addition, there are specific concerns for new Agreements for Commercializing Technology (ACT) transactions, which involve the laboratory contractors acting in a private capacity in the transaction, resulting in a heightened potential for conflicts of interest (COI) to arise. A primary reason for having DOE review all ACT projects prior to work starting under the pilot program is to ensure that the heightened potential for COI is mitigated. To delegate authority for signature (presumably without DOE pre-review) to the laboratories necessarily delegates COI review to the very party that may be conflicted. This is contrary to established COI principles and practices. Similarly, COI can also arise with other technology transfer agreements (work for others and cooperative research and development agreements, or CRADAs), and the same concern also arises for those agreements under this type of delegation.

Finally, such a delegation as it applies to CRADAs would need to be clarified in view of the Stevenson-Wydler Act, at 15 U.S.C. § 3710a (a), which permits the laboratory directors to enter into CRADAs only with an agency-approved joint work statement (JWS) or agency-approved annual strategic plan.

The Department continues to work with the National Labs to streamline the Federal approval process. For example, DOE has recently reduced the requirement for advance payment from 90 days to 60 days, which will lessen the financial burden on the non-Federal sponsors when working with the laboratories. DOE has also recently revised the CRADA Order and included a Short Form CRADA option as a means for simplifying and streamlining the process for projects that meet certain criteria and that do not exceed $500,000. DOE has also recently implemented the "Fast Track" CRADA process for CRADAs valued at less than $3 million, in which expedited site office approval is based on submission of a much abbreviated approval package for proposed CRADAs having work that falls within a DOE-approved annual strategic plan.

Q5. Please provide your evaluation of the initial round of Energy Frontier Research Centers (EFRCs). What opportunities do you see to improve the overall effectiveness of EFRCs?

a. Please describe the Department's plans to evaluate and reaward the second round of EFRCs. Are there organizations that will no longer receive DOE funding?

b. How do EFRCs fit within DOE's Science and Technology programs?

A5. As a group, the 46 EFRCs, initiated in August 2009, have generally been regarded as highly successful. These multi-investigator, multi-disciplinary centers have world-class teams of researchers, often from multiple institutions, bringing together leading

scientists to tackle some of the toughest scientific challenges hampering advances in energy technologies. In 2012 DOE conducted a midterm scientific peer-review of all 46 EFRCs. External reviewers found that the EFRCs: had high productivity; enabled high-risk, high-reward research that would not have otherwise been attempted; brought together synergistic, cross-disciplinary teams that challenge their members to ask difficult questions leading to potentially transformational results; accelerated the rate of both success and failure, from which lessons were rapidly learned and adjustments made; seamlessly integrated synthesis, characterization, theory, and computation to enhance both the quality and quantity of scientific progress; developed outstanding new experimental and theoretical tools, many of which are now available to the entire research community; and, trained next generation energy scientists by involving high quality students and postdoctoral researchers in this cutting-edge research. The details of these accomplishments are contained in the EFRC Report to Congress delivered in January 2013 and are quantified in the following paragraph .

As of August 2013, the EFRCs produced more than 4,000 peer-reviewed journal publications, approximately 200 U.S. and 130 foreign patent applications, and about 90 invention disclosures and 50 licenses. Currently, approximately 850 senior investigators and 2,000 staff and students are involved in the EFRCs. More than a thousand former students and staff have moved on to positions at graduate school or postdoctoral research (400), university faculty and staff (215), industrial research (340), or national laboratories, government agencies, and non-profit organizations (130). Nearly 60 companies have benefited from EFRC research. EFRCs are also making connections across the U.S. energy research enterprise. Each EFRC receives technical

advice from a scientific advisory board composed of scientific and technology leaders in their research area. Among the more than 260 scientific advisory board members across all of the EFRCs, more than 40 companies are represented.

Active stewardship of the EFRCs by the Office of Basic Energy Sciences (BES) has been a hallmark of the program. A variety of mechanisms have been used to assess regularly the ongoing progress of the EFRCs, including annual progress reports, monthly phone calls with the EFRC Directors, periodic Directors' meetings, and on-site visits by program managers. BES has also conducted two in-person reviews by outside experts and has held two Principal Investigators' meetings, bringing together staff, students, and postdoctoral researchers from across the EFRCs to exchange technical results and foster collaboration. BES continually assesses means to strengthen the program and to improve the effectiveness and impact of the EFRCs. Some mechanisms for improvement include the following:

- Strengthen the connections between EFRCs and BES user facilities. Some of the EFRCs have taken full advantage of BES facilities such as light sources, neutron sources, and nanoscience centers. BES fosters these connections by bringing EFRC researchers together with staff and management from the facilities. Such interactions could take place at the periodic EFRC Directors' Meetings, or at separately planned events.
- Further promote interactions and collaboration among EFRCs working in similar areas. This can be done in a variety of ways, including ad-hoc gatherings organized by BES at national scientific meetings, topical Principal

Investigators' Meetings for subsets of the EFRCs, and maintaining a centralized repository for EFRC results and capabilities (especially newly-developed) that is available to all EFRCs.

- Continue to support a balanced portfolio of highly successful EFRCs. A major strength of the EFRCs is the breadth and depth of the program that paves the broad knowledge foundation for energy innovations. The FY 2014 competition will maintain a balanced EFRC portfolio of basic research with potential impact that spans energy production, storage, and use.

A5a. On September 30, 2013 DOE issued a Funding Opportunity Announcement (FOA) for the recompetition of the EFRCs. Both renewal proposals from the existing EFRCs and proposals for new EFRCs were encouraged. Mandatory Letters of Intent were due on November 13, 2013, and the full application due date is January 9, 2014. As with all FOAs, DOE intends to evaluate the eligible applications through a rigorous merit review involving external peer reviewers. Award announcements are expected in June 2014, with award selection based on the outcome of the merit review, program policy factors (as defined in the FOA), and the availability of appropriated funds for the EFRC program.

Of the current 46 EFRCs, 16 were fully funded by the 2009 Recovery Act. The FY 2014 request for EFRCs will likely support approximately 35 EFRCs and the projected awards will be in the $2 million to $4 million range per award per year for 5 years. While the exact makeup of FY 2014 EFRC awards and their affiliated organizations will be determined by the review process outlined above, it is likely that

it will be a mixture of renewal awards for existing centers and new awards for the formation of new EFRCs. All awardees will have demonstrated a great probability of producing high-impact discoveries relevant to energy technologies.

A5b. The Energy Frontier Research Centers (EFRCs), the Advanced Research Projects Agency-Energy (ARPA-E), and the Energy Innovation Hubs, together with the core research activities in the Office of Science and the technology offices, comprise a portfolio of energy R&D modalities that aim to maximize the Nation's ability to accelerate the pace of scientific innovations and energy breakthroughs. While each funding modality has its unique characteristics, DOE has significant internal coordination efforts to maintain their complementarity and provide solid communication of the advances among different offices within the Department. These coordination activities include regular meetings of the program staff, joint planning and reviews of funding opportunity announcements, and joint meetings with the researchers to ensure communication of the latest research advances and technological challenges.

The following are synopses of the unique characteristics and roles of the EFRCs, ARPA-E, and the Energy Innovation Hubs and how they complement each other:

1. Energy Frontier Research Centers advance fundamental science relevant to real-world energy systems. Each focuses on the long term basic research needed to overcome roadblocks to revolutionary energy technologies in a particular area. They are mostly multi-institutional centers composed of a self-assembled group of investigators, often spanning several science and engineering disciplines. This research is both "grand challenge" and "use inspired" basic science

motivated by the need to solve a specific problem, such as energy storage, photoconversion, etc. The choice of topics is at the discretion of the applicants in response to an FOA solicited broadly across grand challenge and use inspired science. The funding range is $2 million to $4 million per year per project.

2. ARPA-E supports energy technology research that is of potentially very high commercial and societal impact but is unlikely to attract private sector investment as a result of high technical and financial risk. ARPA-E follows the Defense Advanced Research Projects Agency's (DARPA) entrepreneurial approach to mission-oriented R&D by funding scientists and technologists to accelerate an immature energy technology with exceptional potential beyond the risk barriers that make it unlikely to attract private investment. ARPA-E does not fund discovery science nor does it support incremental improvements to current technologies. ARPA-E federal program managers take a "hands on" approach to managing the activities of R&D performers. The funding per project may be as low as $500,000 or as high as $10 million. Projects are selected on their potential to make rapid progress toward commercialization and to thereby reduce energy imports, reduce energy-related greenhouse gas and other emissions, and improve energy efficiency.

3. Each Energy Innovation Hub incorporates a large set of investigators spanning science, engineering, and policy disciplines focused on a single critical national need identified by the Department. Talent is drawn from the full spectrum of R&D performers (universities, private industry, non-profits, and government laboratories), who drive each Hub to become a world-leading topical R&D

center. Each Hub's management structure allows empowered scientist-managers to execute quick decisions to shape the course of research. With robust links to industry, the Hubs aim to bridge the gap between basic scientific breakthroughs and industrial commercialization. Awards for the Hubs were openly competed among R&D performers and are for up to $22 million in the first year and up to $25 million in years two through five, for a maximum of up to $122 million over the five-year term, subject to availability of resources.

Q6. DOE's domestic Fusion Energy Science program is facing lower funding levels due to increased financial contribution to ITER; a $20 billion international fusion demonstration' project. Given the budgetary constraints, how will the Department continue to maintain a domestic fusion energy program in current budget environment?

A6. The Fusion Energy Sciences (FES) program is committed to maintaining a practical domestic fusion program even while supporting our contributions to ITER. The FY 2014 budget request provides resources that will continue a dynamic domestic fusion program that makes important contributions to resolving vital issues in fusion research. The FY 2014 budget request continues to build the scientific foundation needed to develop a future fusion energy source. We believe the program is positioned to obtain a high scientific return on our investment in ITER; address gaps in materials science required for harnessing fusion energy; continue stewardship of the broader plasma sciences; leverage cross-agency synergies; and provide opportunities for U.S. scientists to do research on new, billion-dollar-class international facilities where technology investments will enable investigation of a new class of scientific questions..

Q7. The Department is currently conducting a pilot program on a new technology transfer mechanism, known as "Agreements for Commercializing Technology." Please

describe how these agreements differ from existing technology transfer mechanisms, namely Cooperative Research and Development Agreements and Work for Others agreements.

a. How will DOE evaluate the overall effectiveness of the pilot program?

b. On what metrics will the Department determine whether to extend or halt the pilot program?

c. Under the current pilot program, entities that receive Federal funding are prohibited from entering into an ACT agreement with a Lab. Why has the Department placed that stipulation into the pilot program?

d. The Energy Policy Act of 2005 required all recipients of DOE research and development funding to provide for a 20 percent cost share. The law also gave the Secretary of Energy the authority to reduce or eliminate the cost share.

    a. Please provide the number of cost share waivers the Secretary has issued for the most recent three years of data, including the type of entity (i.e. National Lab, non-profit research entity, academic institution, or for-profit entity).

    b. Please provide the total value of the waivers for the most recent three years of data.

    c. Please provide the justification, as required by law, for each cost share waiver for the most recent three years of data.

    d. What is the Department's position on repealing the statutory cost share requirement?

A7. Agreements for Commercializing Technology (ACT) enable DOE laboratories to engage with the private sector using terms that are more consistent with industry practices, while still providing Federal fiduciary oversight and ensuring that Laboratory personnel and resources are available to perform DOE mission work before they are committed to perform work for outside sponsors . Under ACT, DOE authorizes laboratory contractors to conduct third-party sponsored research using government-owned facilities and equipment for the purpose of furthering the Department's technology transfer mission. In exchange for the DOE laboratory contractor assuming

some of the risks and liabilities (e.g., indemnification and advance payment) normally borne by the third party sponsoring research at laboratories via CRADA or work for others (WFO) agreements, the laboratory contractors are authorized to charge sponsoring third parties for additional compensation beyond the direct costs of the work at the Laboratory. In addition, the laboratory contractors negotiate and execute ACT agreements using terms that may be more consistent with private sector business practices including a flexible framework for the negotiations of intellectual property rights.

A7a. The Department will use multiple inputs to evaluate the pilot program before deciding how to proceed. The M&O laboratory contract clause authorizing performance of work under ACT establishes required data reporting that is provided by the laboratory contractor. DOE may request additional information to evaluate ACT processes and agreements during the pilot test stage. A decision whether to continue ACT following the pilot will be made based on many factors including but not limited to:effectiveness in improving technology transfer from the DOE laboratories; impact on contractor ability to achieve primary DOE mission goals; liability and long-term financial risk to Federal government. Other decisions may be whether to extend or expand the pilot to include additional DOE sites, and/or to make modifications to the current ACT model.

A7b. As mentioned, a decision whether to continue ACT following the pilot will be made based on many factors including but not limited to: effectiveness in improving technology transfer from the DOE laboratories; impact on contractor ability to achieve primary DOE mission goals; liability and long-term financial risk to Federal government.

A7c. Although there has been some discussion of the expansion of ACT for sponsors with Federal funds, there are very little data available suggesting that the DOE laboratories are losing work (from sponsors with Federal funds) due to any real and/or perceived limitations in the currently available technology transfer mechanisms like WFOs when a sponsor has Federal funds. The proposed implementation of an ACT-like transaction for sponsors with Federal funds raises several questions regarding the proper use of Federal funds, including whether it is appropriate to use Federal funds to pay for costs exceeding a laboratory's full cost of work performed (under ACT, contractors can charge an additional fee for assuming certain risks for the sponsor) and how to best ensure that there is full disclosure of such costs to both the sponsor and Federal agency funding the work.

In addition, ACT, as it is structured under the existing pilot program for privately sponsored work, does not translate to Federally funded sponsors. It should be noted that some of the key benefits provided through ACT, by law, are not applicable to projects with Federal funding. For example, extending the full terms (i.e., Intellectual Property terms) of ACT to Federally funded partners is not allowed under the Bayh-Dole Act (35 U.S.C. §§ 200-212), governing ownership and reserved Government rights in inventions made under Federal funding agreements. There are also potential issues with flow-down requirements contained in the agreement between the sponsor and the Federal agency that may conflict with the DOE facility contract.

The ACT pilot is still in the early stages and while several pilot sites have signed ACT agreements, so far, one laboratory accounts for more than 90 percent of the agreements. So it is not yet evident whether ACT will be successful and become a preferred

approach when working with a DOE laboratory. DOE continues to collect feedback from representatives from each of the ACT pilot sites and the overall laboratory community. The Department believes it is prudent to consider ACT enhancements or changes after the results of the pilot have been analyzed and in the context of applicable Federal laws and regulations.

A7d.a. Note: The Energy Policy Act of 2005 cost sharing requirement does not apply to research and development "that is of a basic or fundamental nature," if so determined by the Department. As such, The Office of Science has excluded its funded basic research programs from the requirement. (Sec. 988(b)(2)). The Act provides the Secretary broad flexibility to reduce or waive the cost share requirements for other types of R&D activity as deemed necessary and appropriate. In these circumstances the cost share is almost always waived by funding opportunity announcement (FOA) and not by award (i.e., the cost share is waived uniformly for all applicants to a given FOA and the waiver is stated within the FOA; the cost share is not waived selectively for certain awardees). Information on waivers for a specific type of entity is therefore not available. Most waivers cover universities, non-profit organizations and National Laboratories. Thirty-two waivers were issued for FOAs in Fiscal Year (FY) 2011-2013. There are two waivers approved so far for FY 2014.

A7d.b. Because the waivers are applied to an FOA, i.e. prior to selection and award, the total value of the waivers is not available. Not all funding recipients selected through such FOAs with cost share waivers have less than a 20 percent cost share; some meet or exceed this cost share level.

A7d.c. The Department will work to provide this information to your staff.

A7.d.d. The Department is considering this matter in the context of proposed legislation and has not finalized its position.

QUESTIONS FROM REPRESENTATIVE JOSEPH KENNEDY

I would like to address our nation's fusion energy program, an issue that is important to me and one I believe is vitally important to the future of our country's energy security. The Department of Energy and the Administration's budget request has called for eliminating the MIT Alcator C-Mod facility, which has been operating since 1991. For more than 20 years, they have contributed invaluable scientists, research, and advancements to our national fusion program.

I am concerned about how the Administration has proposed this cut, and how you are balancing the direction of U.S. fusion programs and ongoing collaboration with the ITER project in France, which is still in early phases of construction. As I understand it, Alcator C-Mod has a compact, high-magnetic field design that gives it unique capabilities to carry out world-class fusion materials and plasma science research that will be important to ensuring the success of ITER or any other burning plasma reactor; and it does this at a fraction of the cost of other tokamaks at a similar scale. Yet, it does not appear to be in the future plans of the U.S. fusion program, at least in the eyes of the Administration.

Q1. Given the fact that Congress has not authorized its closure, can you speak to the current status of the MIT facility?

A1. The Alcator C-Mod facility is currently in a warm shutdown status. The facility is not operating, but the staff and equipment are maintained such that research operations could resume within one to two months. We plan to maintain C-Mod in this status while waiting for the final FY 2014 appropriation.

Q2. While I understand and believe international collaboration is critical in this field, I have concerns about the process by which this cut was carried out by the Administration on such an important facility. Can you speak to the Administration's plans and priorities when it comes to U.S.-based fusion facilities moving forward? How are you incorporating input from the research community and other stakeholders in the planning process?

A2. The Department of Energy continues to set a high priority on operation of our two existing experimental fusion facilities, the DIII-D facility at General Atomics in California and the National Spherical Torus Experiment facility at Princeton Plasma

Physics Laboratory in New Jersey, to use their world-class and complementary capabilities to perform research in support of the ITER project and guide planning for future experiments. We will use our domestic facilities to maintain and develop world-leading research capabilities which can then be used to enhance our ongoing partnerships in the international fusion research effort. The scale of the cost of fusion facilities has reached the point where collaboration is essential. We can remain globally competitive by maintaining core competencies in key areas while our scientists have access to the best, complementary facilities in the world. Several nations have invested in billion-dollar-class facilities using superconducting magnet technologies. Such experiments have not been constructed in the United States. It is essential that U.S. scientists have access to these facilities so as to be engaged as their research programs mature. The potential payoff from a modest U.S. investment is great, and any international efforts will leverage U.S. capability. In this regard, as result of a competitive solicitation in FY 2013, MIT was selected to lead one of the two U.S. teams to participate in collaborations in two superconducting facilities in China and Korea.

The Fusion Energy Sciences Advisory Committee (FESAC) provides input from the fusion research community and other stakeholders. Several recent FESAC reports have informed the planning process. In particular, the FESAC report *International Collaboration in Fusion Energy Sciences Research: Opportunities and Modes* suggested that an effective mode of international collaboration would be to explore operating limits and control techniques in the flexible and well-understood U.S. facilities followed by international collaboration to extend the promising modes of

operation to long-pulse superconducting facilities abroad. The Department of Energy will continue to utilize FESAC when necessary and appropriate to obtain input from the community on issues of broad impact on the U.S. fusion research program.

Q3. In your written testimony and your dialogue with my colleague, Rep. Randy Hultgren of Illinois, you noted that the Lehman Review of the US ITER project would be submitted in October and that an international management review of ITER collaboration would be presented at the ITER council meeting on November 20-21. When will the results of these two reviews be available to the members of this committee and the public?

A3. The results of these reviews are considered pre-decisional, non-public information. However, the Office of Science would be willing to brief the Members of this Committee or the committee staff on the results of the reviews.

Q4. How can we continue to leverage the expertise of our fusion program to succeed in the ultimate goal of commercializing fusion energy?

A4. Four major scientific and technical issues must be resolved to achieve practical fusion energy: controlling high-performance burning plasmas, taming the plasma-materials interface, conquering nuclear degradation of materials and structures, and harnessing fusion power (i.e., breeding more tritium fuel than is consumed and converting fusion power into electrical power). The scientific and technical challenges associated with these issues are extraordinary and will require exceptional, world-leading experiments to address them.

If ITER succeeds, it will address the first issue and will contribute substantially to resolving the second issue. However, fully addressing all aspects associated with the second, third, and fourth issues will require integrated experiments that can investigate these three issues simultaneously. With this in mind, DOE's Fusion Energy Sciences

program will continue to support a strong domestic program as well as put a premium on developing international partnerships that leverage U.S. strengths and enable DOE to work in an international environment. Together, these investments will position the U.S. to sustain its international leadership in fusion energy science and develop the basis for fusion energy.

Responses by Dr. Horst Simon

Dr. Horst Simon
Deputy Laboratory Director, Lawrence Berkley National Laboratory

1. What opportunities exist to have DOE –and specifically its site offices—reduce day-to-day micromanagement of lab operations? What would the resulting impact be on the Labs?
   a. How can we balance the need for strong oversight and protection of taxpayer funding with providing additional flexibility to the National Labs?
   b. If day-to-day oversight of lab operations is reduced, how can the National Labs be held accountable for their stewardship of American taxpayer-supported investments?

2. Secretary Moniz has expressed great interest in restructuring the Department's relationship with the National Labs. Specifically, Secretary Moniz has proposed creating a National Laboratory Policy Council and the National Laboratory Operations.
   a. What is your perspective on the new Lab Council and Lab Operations Board? How will Labs manage the relationships across the Department, including having multiple reporting lines?

3. Section 109 of the draft legislation directs the Secretary of Energy to coordinate with other Federal agencies to reduce external regulation of National Lab nuclear safety and occupational and health responsibilities. Does Lawrence Berkeley National Lab support this provision?
   a. Please describe the impact of the current workplace regulatory structure on the operations of the National Labs.
   b. How can this transition from DOE regulation to other Federal agency regulation be conducted in an orderly and effective manner?

1a-b.

The health and safety of our employees, guests and neighbors is the first priority for Berkeley Lab and our sister laboratories across the nation. However, an oversight and management system that has become overly transactional and paper driven, confusing due to multiple and often conflicting points of oversight, and unnecessarily costly, is counterproductive and reduces a national laboratory's ability to do science and deliver its national mission priorities.

The most significant negative and inefficient consequences of the current mode of DOE oversight of the national labs derives not from the regulatory structure *per se*, but from the oversight infrastructure and culture within DOE. The complexity of dealing with local DOE site offices, broader area oversight offices, and the multitude of HQ organizations leads inevitably to unclear roles and responsibilities, contradictory guidance, unreasonably long review and approval processes, and ultimately poor risk management practices. Therefore, the single most important transition step DOE could take would be to start reducing the number of oversight

organizations. Rationalizing this to a structure more similar to those of the other federal S&T agencies would be optimal.

Additionally, instead of focusing on process, paper, reporting and multiple layers of oversight, DOE should more robustly utilize the contracting relationships with contractors to manage and properly oversee the performance of the national laboratories. The contracting relationship provides sufficient mechanisms to ensure proper oversight. Specifically, holding individuals and contractors accountable and responsible for performance, including the responses to critiques and the implementation of needed corrections, following reviews or significant events will provide DOE insight into the program and operational health of the organization and will create a stronger and more effective oversight environment than performing burdensome transactional oversight.

2.

As with the implementation of national laboratory oversight, which is necessary and proper to ensure that taxpayer dollars are well spent and well leveraged, the challenge with these new organizations is to ensure that they do not create an additional level of direct authority and responsibility for national lab programmatic and operational management. That said, if organized and managed effectively these councils could serve a very useful role in surfacing issues, discussing solutions and finding resolution to problems and challenges facing the national laboratory complex.

3a-b.

Although Berkeley Lab cannot take official positions as an institution on legislation pending in Congress, national laboratory management officials throughout the system with a strong record of experience and agreement among them, believe that the current application of a DOE national-lab-specific health and safety system is burdensome, costly and duplicative of existing federal resources and activities.

The federal government has well-established and successful regulatory frameworks through agencies, such as OSHA and EPA, and effective oversight mechanisms through established contracting mechanisms (DEAR and FAR) for federal and federally funded research facilities that conduct work activities similar to those found at Department of Energy Office of Science national laboratories. These regulatory regimes effectively and efficiently cover a wide variety of scientific research funded by multiple agencies, such as NIH, NIST, NSF, etc., and conducted at universities, other federal labs, private companies, nonprofit research centers and hospitals. Even DOE Office of Science funded research at institutions other than national laboratories benefit from the consistent application of OSHA and EPA regulation and oversight. There is no need to 'reinvent the wheel' with a unique system of environmental, health and safety regulation and oversight for the low risk research conducted at the Office of Science national laboratories.

Dr. Horst Simon
Deputy Laboratory Director, Lawrence Berkley National Laboratory

Although the specific mechanisms and processes for transferring EH&S regulatory authority from DOE to other relevant agencies would have to be worked out, NRC and OSHA pilots conducted at Berkeley Lab between 1997 and 1999 demonstrated that the transfer could be done relatively easily and would result in less costs, less paperwork and a system in line with other research institutions, such as UC Berkeley at which many of our scientists, post docs, grad students and undergraduate researches also spend lab time. However, it would be counterproductive and even more inefficient and costly if DOE retained a layer of regulatory activity and oversight in this area. The quote below from former Berkeley Lab Director, Charles Shank, before the House Commerce Committee at a hearing on external regulations in 2000 makes this point well.

> *"As a result of these pilot studies, I believe that external regulation of Berkeley Lab is not only possible but also desirable, with the caveat that this is done with clear lines of authority and priority is given to efficient, risk-aware implementation. This would mean that contractors would deal directly with regulatory agencies, and that much of the existing DOE ES&H infrastructure would be reassigned to the Department's core mission. Let me be perfectly clear on this point: a layered, redundant oversight, subjecting the laboratories to regulatory oversight by both the DOE and NRC and OSHA, would result in a more expensive and confusing ES&H climate," Charles Shank, Director, Berkeley Lab, March 22, 2000.*

Responses by Dr. John Hemminger

Providing the Tools for Scientific Discovery and Basic Energy Research: The Department of Energy Science Mission

Response to Questions for the Record

Dr. John C. Hemminger
Chair, Basic Energy Sciences Advisory Committee
Vice Chancellor and Professor of Chemistry
University of California, Irvine
California, 92861 USA

Question: Energy Frontier Research Centers (EFRCs) are small research entities, funded at $2-5 million per year for an initial five year period. Recently the Department of Energy announced its intention to provide another $100 million to fund the second round of centers. Please describe how EFRCs fit into the innovation research ecosystem. What recommendations do you have to improve the overall impact of EFRCs.

Response: Single principle investigator research projects have been the historical hallmark of the highly successful community of scientists working in areas funded by the Office of Basic Energy Sciences (BES). In a 2007 report (*Controlling Matter and Energy: Five Challenges for Science and the Imagination*), the Basic Energy Sciences Advisory Committee (BESAC) stated that Team Science is now becoming increasingly important in areas that have been traditionally driven by single PI activities. In stating this the BESAC report recommended a new program to fund Energy Science Teams. The Energy Frontier Research Center (EFRC) program initiated in 2009 by BES addresses this need. While single PI research projects remain essential to the energy innovation research ecosystem, EFRCs are an important component of the DOE Office of Science funding portfolio. In addition to EFRCs the BES funding portfolio effectively utilizes single PI projects as well as Energy Innovation Hubs. The EFRC funding approach is an effective way to concentrate efforts of investigators with a range of expertise on research problems that are specifically multidisciplinary. On the whole the EFRC program has been an outstanding success. Many of the EFRCs couple scientists from university laboratories with counterparts at the DOE national laboratories. Many interact closely with one or more of the Energy Innovation Hubs. Additionally, some of the EFRCs have effectively coupled experimental projects with theory and computational modeling. While the EFRCs have in general been highly successful, there are always opportunities to enhance the program. It would be useful to encourage and stimulate more close interactions between experimental projects and associated theory and computational modeling. A program that provided more access to the DOE very high end advanced computational resources could be particularly effective. Similarly, an increased access for the EFRC researchers to the BES managed major experimental user facilities could have a significantly positive impact.

Appendix II

ADDITIONAL MATERIAL FOR THE RECORD

SUPPORTING MATERIAL SUBMITTED FOR THE RECORD BY
DR. HORST SIMON, DEPUTY DIRECTOR, LAWRENCE BERKELEY NATIONAL LAB

U.S. Department of Energy
Office of Science User Facilities, FY 2013

Facility	Host institution
Advanced Scientific Research Computing (ASCR)	
National Energy Research Scientific Computing Center (NERSC)	LBNL
Argonne Leadership Computing Facility (ALCF)	ANL
Oak Ridge Leadership Computing Facility (OLCF)	ORNL
Energy Sciences Network (ESnet)	LBNL
Basic Energy Sciences (BES)	
Light Sources	
Advanced Light Source (ALS)	LBNL
Advanced Photon Source (APS)	ANL
Linac Coherent Light Source (LCLS)	SLAC
National Synchrotron Light Source (NSLS)	BNL
Stanford Synchrotron Radiation Light Source (SSRL)	SLAC
Neutron Sources	
High Flux Isotope Reactor (HFIR)	ORNL
Spallation Neutron Source (SNS)	ORNL
Lujan Neutron Scattering Center	LANL
Nanoscale Science Research Centers	
Center for Functional Nanomaterials (CFN)	BNL
Center for Integrated Nanotechnologies (CINT)	Sandia/LANL
Center for Nanophase Materials Sciences (CNMS)	ORNL
Center for Nanoscale Materials (CNM)	ANL
The Molecular Foundry	LBNL
Electron Beam Microcharacterization Centers	
National Center for Electron Microscopy (NCEM)	LBNL
Electron Microscopy Center for Materials Research	ANL
Shared Research Equipment Program (ShaRE)	ORNL
Biological and Environmental Research (BER)	
Environmental Molecular Sciences Laboratory (EMSL)	PNNL
Atmospheric Radiation Measurement Climate Research Facility (ARM)	Global network
Joint Genome Institute (JGI)	LBNL
Fusion Energy Sciences (FES)	
DIII-D	General Atomics
National Spherical Torus Experiment (NSTX)	PPPL
Alcator C-Mod	MIT
High Energy Physics (HEP)	
Fermilab Accelerator Complex	FNAL
Facility for Advanced Accelerator Experimental Tests (FACET)	SLAC
Nuclear Physics (NP)	
Continuous Electron Beam Accelerator Facility (CEBAF)	TJNAF
Relativistic Heavy Ion Collider (RHIC)	BNL
Argonne Tandem Linac Accelerator System (ATLAS)	ANL

Updated October 1, 2012

Testimony of Dr. Charles V. Shank
Director, Lawrence Berkeley National Laboratory
Before the
House Commerce Committee
Subcommittee on Energy and Power
March 22, 2000

Mr. Chairman and Members of the Subcommittee:

It is my pleasure to be here today to provide my perspective on three bills dealing with the environment, health and safety of the Department of Energy complex.

Just to reacquaint you, Berkeley Lab is the oldest of the DOE national laboratories, founded in 1931 and located next door to the University of California, Berkeley campus. Today we operate on a budget of approximately $415 million performing research for the Department of Energy (DOE), other Federal agencies and the private sector. Before becoming Director of the Lawrence Berkeley National Laboratory in 1989, I spent 20 years at the AT&T Bell Laboratories, ultimately directing the Electronics Research Laboratory in Holmdel, New Jersey. In addition, I now serve as Professor in three Departments at the University of California at Berkeley, in Physics, Chemistry and Electrical Engineering and Computing Sciences.

The regulatory framework for the national laboratories is important for their scientific productivity, the safety of our employees, and the protection of the environment. Providing a safe and healthy environment is a critical management responsibility of the Laboratory Directors.

The first bill, H.R. 3383, would eliminate the exemption for non-profit contractors from paying fines and penalties levied under the Price-Anderson Act. As the University of California official responsible for managing my laboratory, I take compliance with the Price-Anderson Act very seriously. I am proud of the fact that we have an outstanding record of operating safely and of demonstrating the utmost concern for the environment.

The University operates the Lawrence Berkeley National Laboratory, along with the Livermore and Los Alamos laboratories, as a public service without the desire for financial gain, and has instituted numerous mechanisms to insure compliance with Price-Anderson and all Federal and state statutes. The fees paid to the University for their management activities are derived from support for the laboratories' scientific programs. Therefore, any additional fees that might be paid as fines and penalties would be additional "taxes" on our research programs, while not increasing our outstanding level of compliance.

The second piece of legislation, H.R. 3906, would establish a new Office of Independent Security Oversight within the Department, along with additional procedures for safeguards and security evaluations. I want to point out that Lawrence Berkeley National Laboratory performs no classified research on its site and has no ability to store classified information on site. We do, however, operate DOE's largest civilian supercomputing facility, along with managing DOE's Internet operation, so we do take seriously cyber security and other security measures appropriate for our site.

My concern with the measures proposed in H.R. 3906 is that it imposes yet another new layer of bureaucratic management and oversight. A successful security program requires line management accountability and employee support. This bill will apply yet another burden on the scientific programs performed at the laboratories.

Finally, let me turn to H.R. 3907, which would provide for external regulation of nuclear safety and occupational health and safety at DOE facilities. I would like first to talk about our experience with external regulation pilot studies with both the Nuclear Regulatory Commission (NRC) and the Occupational Health and Safety Commission (OSHA), and then turn to some more general comments about the legislation.

As you may know, Berkeley Lab is located adjacent to the University of California, Berkeley campus, and we share many faculty and students. For many years, it has mystified me that identical activities carried out on the campus and at the laboratory are regulated by different entities, and with different standards. As a consequence, when NRC proposed a pilot project for external regulation of DOE facilities, I quickly volunteered our institution. My dream is for a world where similar work is regulated with uniform standards independent of the entity that performs the work. Scientists could then be trained with a single set of expectations for environment, health and safety considerations throughout the country.

The NRC pilot took place between October 1997 and January 1998, with two planning visits to the laboratory, two one-week simulated regulation visits, and a public meeting to seek community input and comments. The results of the pilot were encouraging. NRC found that there were no significant safety findings to report, and that the laboratory had an adequate program to protect the health and safety of employees, the public and the environment. The NRC indicated that they would be willing at that time to issue the laboratory a broad scope license for their operation, and indicated that they could carry out their responsibility for our site with 0.1 FTE, or approximately one person-month per year.

There are, however, a number of serious concerns. Would external regulation be layered on top of current DOE orders? We fear a world of overlapping and redundant responsibilities that would make it difficult for us to do our work. Who will hold the NRC license? The DOE report on our pilot indicates that additional people would have to be hired if DOE held the license. Who will be responsible for legacy issues? We at Berkeley Lab have old facilities for which clean-up funds have not been allotted. Who will regulate x-ray units, accelerators and naturally occurring radioactive materials?

Based on our experience with the NRC pilot, and the private sector experience of our ES&H staff, we volunteered to conduct a similar pilot with OSHA. This effort took place between December, 1998 and January 1999. It involved two planning conference calls, one eight-day site visit, an all-hands meeting with laboratory staff and meetings with our local labor unions. The visiting team included representatives from NRC, DOE, OSHA,

Cal-OSHA, the California Department of Health Services and the EPA. They reviewed all our facilities and programs applying the concept of simulated regulation and inspection, with comprehensive safety and health inspections and simulated citations for alleged violations.

The overall conclusion was that the OSHA regulatory framework could be applied to Berkeley Lab, and that the laboratory's Integrated Safety Management program is consistent with OSHA's Voluntary Protection Program. OSHA did identify 63 simulated citations, for a total simulated penalty of $57,700 or an average of $916.00 per violation. They also had a number of issues that would need further attention, but none of them could be considered significant enough to prevent their efficient regulation of the site.

As a result of these pilot studies, I believe that external regulation of Berkeley Lab is not only possible but also desirable, with the caveat that this is done with clear lines of authority and priority is given to efficient, risk-aware implementation. This would mean that contractors would deal directly with regulatory agencies, and that much of the existing DOE ES&H infrastructure would be reassigned to the Department's core mission. Let me be perfectly clear on this point: a layered, redundant oversight, subjecting the laboratories to regulatory oversight by both the DOE and NRC and OSHA, would result in a more expensive and confusing ES&H climate.

Finally, I am very concerned that the results of these pilots not be used to generalize this approach to all the work performed at DOE facilities. In some cases, such as at weapons

laboratories and production facilities, external regulation may not be desirable owing to the specialized expertise necessary for managing risks in unique facilities and security concerns.